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THE FUTURE OF RADIOLOGY AS A MEDICAL SPECIALTY*

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THIS American Congress of Radiology is, in a measure, commemorative of thirty-seven years of progress in American Radiology, and there could be no more fitting occasion for such a celebration than that of One Hundred Years of Progress here in Chicago. No greater progress has ever been made in science than has resulted from the discovery of the roentgen ray and radioactivity. It has been fortunate for medicine that these physical agencies could have been so advantageously applied as to have created one of the greatest boons to humanity along medical lines, second only to what has followed as the result of the discovery of bacteria. Radiology is the youngest of the medical specialties, and more rapid strides have been made in its development in a shorter period of time than can be claimed for any of the others.

The true concept of Radiology today is not altogether what we as radiologists think of it as a specialty in medicine, but more important still is the regard which the medical profession as a whole, and even the laity, holds for it and for us who practice it. We as radiologists may assume that our specialty occupies a satisfactory standing, but we have been made to realize at times that we are not above reproach and we must conclude that our position is not ideal in every respect.

Many obstacles have been overcome and numerous pitfalls have been escaped in the nearly thirty-eight years of evolution since the discovery of the roentgen ray. Opportunities for moral and physical obstruction to the advancement of radiology as a specialty have been prevalent during most of this time and are still as active as ever. Probably the most serious of these can be grouped in the inclinations, and even the direct attempts, by various means to belittle our ideals for specialization. But it is by overcoming these obstacles and pitfalls of the past that we have been stimulated to an ethical activity which has placed us in the position we occupy today. Many years ago, in school boy days, I was greatly impressed by a statement accredited to a well-known Philadelphia ship builder, "God bless the man who has placed obstacles in my way." Added years of life's experience have served for personal confirmations of the applicability of this trite saying, and I am sure that the obstacles which we as radiologists have met and overcome have proved to be undoubted stimuli towards the attainment of some of our ideals.

The requirements of specialization in radiology are perhaps more numerous and complex than for any other specialty in our profession, with the exceptions of the major branches of medicine and surgery. This

* Presidential Address delivered before the first American Congress of Radiology, Chicago, Ill., Sept. 25–30, 1933.

statement does not imply, however, that it is more difficult to comply with them nor that a higher standing is warranted than in the other special branches. The very complexity of ideal requirements and the lack of a general understanding of them by other members of the medical profession and the laity is a very important factor in the difficulty in keeping up the high standard which radiology deserves.

In the very early period of the medical application of the newly discovered radiations a cursory knowledge of electricity and of high tension apparatus, together with the ability to carry out the details of dark room development sufficed for the work then possible. That, in fact, constituted my own personal teaching experience thirty-one years ago, in addition, however, to a basic medical training. As a result of the little special training required and the lack of experience available, the institutional druggist or the laboratory assistant or technician could soon learn all there was to be done in the way of technique in the routine examinations then possible. These individuals were designated by such high sounding but meaningless terms as skiagrapher or actinographer. The rapid development of a special line of work in the hands of medical men soon swept these non-professional technicians into the discard, but the stigmata of this early practice in a later specialty still clings to it. It is interesting to recall that surgery developed in much the same way, in being, to a certain extent, in its incipiency, in the hands of the barber, although the history of the two specialties is hardly comparable because of the fact that surgery began in the darker ages and radiology in a modern period of enlightenment. They are, in a measure comparable, however, in the fact that medicine was not ready for either procedure as a specialty in the appropriate period of its then undeveloped state.

In later years, we, as radiological specialists, have been obliged to employ non-medical technicians for the performance of a large part of our purely technical work because we have had to give our time to the far more important phases of interviewing patients, interpretation, consultations, planning treatment to be carried out, working out new technical problems, teaching, writing and keeping abreast of the endless literature on our subject. The employment of technicians to work under our direction has afforded opportunities for an unfortunate aspect to our present situation in addition to being an absolute necessity for our work. The following incidents serve to illustrate this point:

This advertisement appeared recently in a prominent newspaper of one of our large eastern cities:

> Young lady, registered nurse, X-ray expert, industrial clinic experience, needs work; will accept position in doctor's office at reduced salary.

The second example is, perhaps, still more pernicious. A young non-medical man who had obtained training as a roentgen-ray technician was staked by his father to an office and equipment in a city in Pennsylvania of several thousand inhabitants for the purpose of practicing private roentgenological work. In addition to this, he received the appointment as roentgenologist in the local hospital. This young man has progressed so far as to attempt gastrointestinal diagnoses.

In addition to these and very many other similar performances among non-medical individuals of attempting to practice what is generally accepted as a medical specialty, we may step just within the bounds of the ethical scale and include many instances of high pressure salesmanship intended to induce the purchase of roentgen-ray equipment by physicians who have had no training whatever except that necessary to operate the machine, and who are entirely ignorant of the dangers and risks they assume or how to avoid them. It is rather common knowledge that such equipment has been sold in this way under the conveyed impression that training and experience are quite unessential.

It is to be conceded that the technical

side of roentgenology, or at least of the diagnostic aspect, is comparatively easy to master under adequate instruction. It is comparable to the work of the laboratory technician. While correct roentgenographic technique is of the utmost importance, it is, in reality, the simplest and easiest part of the entire diagnostic procedure, and requires little more than a cursory knowledge of physics and electricity to begin with, followed by some experience in handling roentgen-ray equipment, a general familiarity with gross anatomy, a more intimate acquaintance with the relations of penetration, exposure time and thickness and density of the part examined, together with a full realization of the essential safety factors. Strange as it may seem, however, this minor part of the entire diagnostic procedure appeals to a large proportion of the medical profession and the laity as the sum total of an examination and resulting diagnosis. This is frequently due, in a large measure, to the fact that the mysteriousness of the technical portion of roentgenography overshadows the true import of the clinical part of the procedure. As a result of this lack of comprehension we are met by the following undesirable situations which are greatly in need of correction:

1. A large part of the medical profession is quite ignorant of the scope of roentgen diagnosis and radiation treatment, of the principles upon which both are based and of the essentials for proper training of a fully informed specialist in roentgenology. Truly this situation is deplorable in some portions of this country as all of us realize from personal experiences and has been proved by the investigations made by the field representatives of the American Society for the Control of Cancer. Some slight encouragement may be found, however, in the fact that in many localities similar attitudes are prevalent in respect to specialties in general.

2. The second situation has been expressed very appropriately by Dr. Francis Carter Wood in a recent editorial in the *American Journal of Cancer*,[1] in which he states that hospital authorities are apt to take the point of view that a roentgenologist is employed by an institution solely to prepare films for diagnostic purposes and to write short, objective reports on his findings, and under many existing conditions the roentgenologist (so-called) is but little more than a glorified technician. To this we might add that such situations are very frequently retroactive, for it is common practice among us, and even among our non-radiological colleagues, to partly judge of the efficiency of hospitals by the clinical and technical quality of the roentgen diagnostic work which emanates from them and the soundness of the principles which quite evidently underlie the character of radiation therapy practiced.

3. A third situation is also covered by a further statement by Dr. Wood, a surgeon, pathologist, radiologist and journalist, and therefore a man who has a full realization of conditions from an unbiased viewpoint, to the effect that many so-called radiologists are not fitted for internal medicine or surgery and take up radiology as a means of living with a minimum of medical knowledge and ability. We must realize that this is only too true and that such individuals never rise much above the level of technicians. As a matter of fact, some of them are very poor technicians, judging by the character of their work which we encounter all too frequently, to say nothing of their opinions.

4. A fourth undesirable situation arises from the fact that quackery is stimulated because of the attitude of the medical profession toward the technician problem. It should be borne in mind that the encouragement of the commercial laboratory under technician control only serves to stimulate fully fledged quackery along other lines. If the roentgen ray is used in a commercial laboratory for the treatment of cancer, and the procedure is encouraged, it

[1] Wood, F. C. The position of the radiologist and radiotherapeutist in the hospital scheme. Editorial. *Am. J. Cancer*, February, 1933, *17*, 462.

is only a slight degree better than the recognition of the "quack" who uses other agencies in the treatment of disease, and which we frown upon and do not recognize.

Having determined what seems to be the most serious situations which react in a manner detrimental to the best interests of radiology and against its best services to the medical profession and to humanity, let us consider the remedial measures best suited to counteract these tendencies. We may enumerate the most important of these as follows:

1. The proper education and training of radiologists.

2. The education of medical students and interns in the true meaning and scope of scientific medical radiology with a view to inculcating in them an ability to decide between useful and useless radiological assistance in their future problems.

3. Avoidance of the commercial laboratory and the recognition of radiology as strictly a medical practice.

4. The moral effect of radiological societies in general and of this Congress in particular.

5. The appointment of a Qualification Board for the approval of radiologists as specialists.

These measures will be considered now in further detail:

1. Much has been written upon the proper education of those who propose to practice radiology, and the subject has been very adequately covered. While these efforts may seem, on the surface, to have been without effect, a few rays of sunshine are beginning to appear through the clouds. The real objects of all the proposed plans of instruction of today are to elevate roentgen diagnosis from purely a laboratory procedure to a clinical specialty, radiation therapy to a rationally scientific and accurate procedure and the radiologist to the position of a consultant in diagnosis, and a highly trained specialist in the treatment of diseases in which radiation therapy is indicated. Failing in these objectives, the would-be radiologist cannot be regarded as holding a position in higher standing than the unethically adjudged commercial laboratory. The first requisite in his training is a previous clinical experience in both medicine and surgery, if he expects ever to pose as a clinical consultant. This part of his training implies a satisfactory hospital internship, preferably of two years. Following this, it is highly desirable, though not absolutely essential, that he shall have engaged for a while in general practice. During these years of pre-radiological experience, autopsy work will prove to be of incalculable value later on. At the present time the actual training in radiology *must* (not may) be acquired in any one of three ways: as an assistant to a radiologist of recognized standing; as a student in a graduate school of medicine in which provisions are made for a thorough course in radiology; as a fellow in radiology in a busy, and well equipped and manned department in a large teaching hospital. The last two of these means of instruction should cover a period of not less than one year, and preferably twice that long. If the course is but one year, the student radiologist should work for a longer period as an assistant before attempting to practice on his own initiative. It is to be hoped that the stringency of examinations before a future Qualifying Board will be such that even a two years' post graduate training or fellowship will not permit a man to qualify as a specialist, unless by chance he was engaged in radiological work previous to his special course, and for a sufficient time to have acquired considerable experience. A physician with one year's intensive instruction would be far preferable in a small institution, however, to a technician employed for presumable diagnosis without any clinical, pathological or physiological knowledge. In addition to training in radiology alone, there must be inculcated in the properly trained student of radiology a thorough knowledge of physics so far as it applies to his work, because while working, he must always be thinking, though unconsciously perhaps, in terms of the

physical problems at hand. He must also have an intimate knowledge of anatomy and histology. He must be conversant with many problems of physiology, especially in connection with the digestive tract, the heart, respiration and the cerebrospinal fluid system. He must also know physiological actions as they have been determined in some respects only by roentgenological observation, as in connection with the swallowing act and gastrointestinal motility. Above all, he must know pathology, primarily, because the roentgenogram is a portrayal of pathological processes in the living subject and as they may modify or be modified by the functions of life, and roentgenographic interpretations must be made entirely on such a basis. Furthermore, his knowledge of pathology must be applicable to the conditions he may be called upon to treat. Finally, as a diagnostician, he must gain experience in identifying normal roentgenological appearances, variations within normal limits, the recognition of pathological processes and the differentiation between those which present similar abnormal features. All these factors must be adequately developed to admit one to the privileges of consultations in connection with medical and surgical cases and also those falling within the provinces of any of the specialties. Radiologists who give instruction along any of the lines mentioned should be morally bound to select for their students only those who have desirable personalities and abilities such as will tend to elevate the standards of radiology.

2. We still have before us the much discussed problem of the instruction of the undergraduate student whose curriculum is already overcrowded without the addition of radiological teaching. All the specialties are clamoring for a share of the roster schedule. There is no good reason for ascribing this to a purely selfish motive and every specialist on a teaching faculty has a humanitarian basis for his instructional desires. Let us analyze our own motives. The medical student is to become an intern and eventually a practicing physician. In both instances he is to come daily in more or less intimate contact with some aspect of radiology. He must become familiar with its scope, the indications for its use and its shortcomings, in order to place proper dependence upon it and not waste time, labor or institutional funds or patients' incomes unnecessarily when its assistance is not indicated or required. He must also be able to form some opinion as to which individuals who are radiologists, or posing as such, can assist him by dependable work and advice. He must be one of those in the future to help expurgate the medical field of commercialism, quackery and incompetency. It seems reasonable, therefore, that the undergraduate period should constitute the beginning stage of familiarity with radiology for the reasons stated, and not because of any expectation that he may practice it. It is unnecessary, for the purposes just set forth, that any curriculum be augmented by more than a very small minimum of direct radiological instruction. The necessary rudiments can be readily affixed as portions of the general instruction in the preclinical branches of anatomy, physiology and pathology and the clinical courses in medicine, surgery and the specialties, so far as radiology applies intimately to those subjects. We have fully explained the proposed method in a previous communication,[2] and we know that such instruction is being carried out successfully in many institutions.

The hospital intern comes in daily contact with radiological problems to a considerable extent, and we have found him particularly receptive to instruction. Moreover, he has more time than the undergraduate student and there is no curriculum to bother anyone. During such an instruction period the elementary principles dealt with during undergraduate years can be greatly broadened, and clinical applications are innumerable. The instruction period is a valuable one and more advantage should be taken of it.

[2] Pancoast, H. K. Teaching of radiology to undergraduate students. *J. Am. M. Ass.*, 1932, *98*, 938.

3. The subject of commercialism has already been discussed from the standpoint of warning the student against it. It is difficult to conceive how any ethical physician can conscientiously do anything to foster its progress as a substitute for professional radiology, which has the recognition of all important medical societies as a specialty in medicine. Commercialism is being encouraged, however, and, sad to relate, even exploited in a way. Truly we must depend upon the education of the undergraduate student and the intern to avoid this calamity to our specialty, and, in the end, to the entire medical profession. We may not be able to influence those of the older generation who lack the proper respect for ethics, but we can persuade those of the next genealogical rank to recognize the great importance of properly trained and experienced radiological specialists.

4. The moral effects of our various societies upon ourselves and others is not fully realized by many of us. In each one of them there is instilled a spirit of cooperation toward the attainment of high ideals which stimulates each member, and especially the younger ones, to do his best for service to mankind as well as his society and himself. There is room for more than one society. Each fulfills a definite purpose and, at the same time, creates a spirit of healthy and profitable competition in scientific radiology. One important duty we all lack, and that is the creation of a cooperative attitude between ourselves and the manufacturers of equipment, leading to the development of apparatus which shall satisfactorily take care of advanced requirements, ensure to everybody the greatest degree of safety in installation and operation, eliminate the useless reduplications of effort for only slight modifications which are conducive to increased installation costs, and, finally, the standardization of parts which would tend to reduce manufacturing costs.

While the four societies sponsoring this Congress may have slightly different minor aims and objects, there are larger problems which we can work out only collectively. Some of these have already been discussed, and another will be considered next. It seems that our Congress is being held just at the appropriate time to engender a spirit of cooperation between us that is very much needed at present to solve our difficulties and to elevate Radiology to its proper level before the medical profession and even the lay public.

5. Probably the most important step ever taken to place radiology upon an appropriate standing is the formation of a Qualification Board. The proper functioning of such a Board almost automatically creates a standard which will tend to become higher as time goes on, just as have been the experiences following the operations of similar Boards connected with other specialties. The manner in which the inception of our own Board was worked out and the attending incidents were most propitious from the standpoint of the favor with which radiology is viewed by members of other Qualifying Boards, the Council on Medical Education and Hospitals of the American Medical Association and the National Board of Examiners. It is most encouraging to realize that the personnel of our own Board for the Qualification of Specialists in Radiology is now complete and the Board is now ready for definite action. At a meeting in Milwaukee in June of various individuals interested, and prior to the formation of our Board, it was decided to create a general Advisory Committee or Board comprising two representatives from each Qualifying Board, the Committee on Medical Education and Hospitals of the American Medical Association and the National Board of Examiners. This all seems like a dream come true for radiology and we may now hope to have our specialty placed upon a proper basis and some of our serious problems near solution. These happenings of recent months must show us that the specialties of medicine are not self-centered groups, but are cooperative bodies quite willing to help each other when crises arise.

Every radiologist must not jump to the conclusion that he can at once apply to the Board to pass an examination and qualify as a specialist in radiology. The process will, of necessity, be a slow one. The examinations will, or should be, rigid and complete, and there are likely to be many disappointments. A physician's diploma and license to practice medicine permits him also to practice radiology, but only the Board's opinion of his fitness can qualify him to practice radiology as a specialist.

In closing, attention should be called to the fact that we, as radiologists, are apt to think that radiology is entirely what we have made it by our own collective exertions and experiences. In this view we are mistaken, and were it true, we would not have advanced to the position we now occupy. A well-known author[3] has stated that "experience has its dangers: it may bring wisdom but it may also bring stiffness and cause hardened deposits in the mind, and the resulting inelasticity is crippling." We must not lose sight of the fact that our progress has been materially abetted by a considerable amount of assistance from outside sources. The physicist, Roentgen, started us on our way, and others of the world's most renowned men of the same scientific group have helped very materially in our advancement. The distinguished Madame Curie will probably have greater renown for what she initiated in radiology than even for what she did for the science of physics. We have called upon the anatomist for help as well as helping him. Where would we be in therapy today without the incalculable value of the assistance given us by pathologists like Ewing and Broders and others in such important standardizations as the classifications of tumors and their relative radiosensitivity? We have depended upon Failla and his coworkers, working on the latter basis, to tell us how to get an appropriate dosage into a tumor. We have to thank Dandy for surgical procedures making possible the examinations of ventriculography and encephalography, in 1919 to 1920. Graham and Cole first gave us the long desired solution for gallbladder visualization in 1924. We are indebted to Rowntree, Osborne, Sutherland and Scholl for the first intimations of the possibilities of intravenous urography, and to Swick, working with von Lichtenberg, for bringing the procedure into practical use. Mention might be made of a host of others deserving of our gratitude for their assistance in building up our specialty. We must regard all of our own work of nearly four decades aided by the assistance of many willing helpers, as a precious possession not to be robbed of any of its merits by unethical, unscrupulous and non-medical usurpers.

Finally, let us do honor to the host of our fellows who have lost their lives that radiology might advance and that humanity might benefit. We older ones who have survived and the younger generation who have profited by the fatal experiences of our pioneer predecessors must pause and express gratitude to the unfortunate ones who died that we might live and prosper and do honor to their memory.

[3] Benson, E. F. As We Are. Longmans, Green and Co., 1932.

INFLUENCES AFFECTING THE FUTURE OF ROENTGENOLOGY*

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MY FIRST official act as President of the American Roentgen Ray Society is to thank the members of the Society for this honor. When one looks back over the list of the men who have held this office, what they have accomplished for medicine and roentgenology, one is impressed by the honor of being placed in this list and by the responsibility entailed. I hope I may be able to bear the honor with becoming modesty. The responsibility, however, is a more difficult problem.

When the President of the United States is inducted into office, he makes his inaugural address. This is supposed to be a brief review of the condition of the nation as he sees it and such remedies as he may suggest for the solution. So I have prepared a paper in which I shall endeavor to give my views on the condition of roentgenology and some of the problems that we now face.

It may seem trite to say that roentgenology is at a fork in the road. However, I think this is so, for I can see at least three roads it may take. First, it may be absorbed in the general practice of medicine. Second, it may be split up into a number of specialties, and third, it may remain as it is. The underlying forces that may influence its course are complex, and all of the future cannot be foretold today. Nevertheless, it will not be out of place to survey the situation, taking into account the past and the present. In this way we may be in a better position to do our part in shaping conditions, so that whichever road is taken will be the best for the future of medicine.

The Constitution of the American Roentgen Ray Society in its preamble makes two stipulations as objects for the existence of the Society. 1. To improve the science of roentgenology. 2. To maintain roentgenology as a specialty. The first is important but in my opinion it is no more so than the second, for it is my belief that the future of medicine will be best served if roentgenology remains a specialty, led by men whose entire endeavor is given to this field alone.

Our efforts to improve the science of roentgenology in the past have been well done, and these efforts will be continued. There are some who will say that if we improve the science of roentgenology, it will remain a specialty. They are, I believe, only partially correct, for incorporated in this second stipulation is the economic side. This economic side plays as important a rôle in the future of the science of roentgenology as it does in the entire field of medicine. To me, it seems that as much effort should be made to maintain roentgenology as a specialty as we have used in the past to advance it scientifically.

Most of the branches of medicine took centuries to develop, but roentgenology, the offspring of pure science, born in the most scientific age of the world's history, has matured in forty years. Its advice is sought and followed in all fields of medicine. To understand the problems ahead, if roentgenology is to be maintained as a special field of medicine, one must know something of the conditions which surrounded its birth and growth, what influences affected it during this growth and the problems it now faces, because we, who are its devotees, must meet these problems. Our actions will do much to shape its future.

Let us consider the environment under which early roentgenology was nurtured. When, in 1895, Roentgen's epochal announcement of an invisible ray startled the scientific world, many were the uses suggested. Some were fantastic; some were

* Presidential Address delivered before the American Roentgen Ray Society during the American Congress of Radiology, Chicago, Ill., Sept. 25–30, 1933.

practical. To the serious thinkers it was the dawn of a new era, and they started experimenting. Many men, however, attracted by the unknown, men not well trained, but of an inquisitive mind or mechanical bent also procured the necessary apparatus to produce these new rays. Their tribulations with equipment were many. Much of the apparatus had to be built by the experimenters. Tubes were of the poorest. Exposures were long, and the results were disheartening. But when the basic principle of the rays (the ability to penetrate objects and cast shadows in proportion to their density) was brought to the attention of medical men, they recognized the advantage their use would produce in the localization of foreign bodies and in the diagnosis of fractures. This demand for its use soon became general. As many of the very early experimenters had no medical and little scientific training, it was to these untrained investigators that medical men most often had to turn, for its use demanded that it be obtained wherever possible. In many parts of the country these men were the first to produce roentgenograms.

These first simple uses required little or no medical knowledge, and it was only as progress was made that the necessity of interpretation in the light of medical knowledge became apparent. The fact, however, that many of the early workers were fitted only for the technical work introduced into a medical field men without medical ideals. Many of these men have passed on, or have left the field. Some of these pioneers, stimulated by the contact with medicine, acquired a large amount of medical knowledge and have rendered good service. Some even took the necessary work to acquire a medical degree. To this non-medical influence was added another and more difficult problem. There were no set standards of training and few places to secure even a meager knowledge of the work. Everyone was thrown upon his own resources and acquired what knowledge he could. The field looked lucrative from the outside, and appeared to offer a higher professional standing. As a result many medical men, some failures in general practice, with little special knowledge, entered this field. These men often possessed poor technical ability, and so, to the technician without medical knowledge, was added the poorly trained physician, more dangerous to roentgenology than the non-medical technician, because nothing distinguished him from his well-trained medical collegue.

The older men who have carried roentgenology forward will recognize this picture. It is they who know of the strenuous battles fought around the standards of scientific progress; where, because of a lack of knowledge on the part of the profession and of the laity, reports of the charlatan and the misinformed were given the same credence as were the scientific opinions of qualified men. To men in large centers these days seem long since passed, but I am sure that there are few of them who do not even now have films referred to them for diagnosis in which both the technical skill used and the opinion expressed leave much to be desired.

Lay technicians, who render medical reports, have almost passed. However, because of past history, a heritage still remains in the minds of many persons connected with medicine and hospitals; it is the idea that roentgenologists require no elaborate medical training. Many still feel that the production of films of sufficient excellence is enough, and that anyone can interpret them. This is much in evidence among surgeons and internists, men who would be the first to denounce the roentgenologist for removing an appendix or treating a case of nephritis, but who at the same time do not hesitate to diagnose a gastric ulcer from a set of roentgenograms made by a technician, even though in the present day system of medical training the roentgenologist is far better trained in surgery and medicine than the surgeon or the internist is in roentgenology.

Another factor (and one present from the first, but of growing importance) is that the

general use of roentgenology in medical practice requires that all hospitals be equipped with expensive apparatus, and the personnel to properly operate this apparatus. Sufficient space must be provided for this machinery. These physical and costly sides often overshadow in the lay mind, and often in the mind of the medical staff, the most important part, the correct interpretation of the roentgenograms.

A further complication, resulting from the older days, which, although not justified at present, still persists, began when the profession and hospital authorities saw men of little or no scientific attainments making money out of all proportion to their training and ability. It was only natural that medical men and these institutions should feel that they were overpaid, and that part of this money might be rightfully diverted to the use of the institution. So arose the pernicious idea that the roentgenological department was a legitimate source of income, and a profit from the roentgenologist's efforts could be diverted to other uses. The fact that when medical men became involved this practice was contrary to the ethics of medicine was not only allowed to pass unnoticed by physicians, but institutions were encouraged by the medical staff to do this, because shortsightedly they did not see that this was basic and in time would undermine the entire structure of medicine, sooner or later reacting to their disadvantage by establishing a precedent, a precedent which would quickly be used by the unscrupulous to carry the same practice into their fields. The consultant roentgenologist of the present day (because of the importance of his work) is worthy of and should receive financial returns comparable with any member of the hospital staff.

But today we are primarily interested in roentgenology. We know how the scientific side has advanced. To maintain the standards of scientific advancement, men of ability must be attracted to it, and while I believe but few medical men are actuated by the emolument offered, when a young man of ability, having a choice of goals, one leading to competence and the medical respect of the surgeon, the other to relative dependence and the medical inferiority of the average roentgenologist, his choice will not be long in the making. The most able man will go into surgery, and leave roentgenology to others less capable. It is in this respect that the economic can do the scientific side irreparable wrong. Roentgenology, called upon to fill a major place in medicine, will suffer scientifically unless it is treated both economically and scientifically as an equal.-But you may say that this is so and I will grant that in some places, guided by a strong personality and unusual ability, such recognition *has* been given; but that this is not universal is not hard to prove. One may say that these conditions are often justified, that they are due to the looseness in the use of the term "specialist," to the ease with which one may gain recognition without qualifications, but too many times they are due more to past influence than to the qualifications of the present-day roentgenologist. Poorly qualified men are still to be found, and this is one of our problems.

In looking over the younger men in recent years, one must take heart at their universal excellence, but if you analyze the situation you will find that they have all been trained under the guidance of a few men and at some of the ideal places. Most of them have encountered a rude awakening when thrown upon the practical world, both in the emoluments they may obtain and their standing on the staff of the institution they serve. And this is not due to an oversupply of qualified men. It is due to faulty ideas of their value, and to improperly prepared soil for their reception. The cost of medical care has been much in our minds and the indifference of institutions to good roentgenologists may easily be one of the causes, because good medical care is the cheapest. Correct diagnosis and treatment applied early often obviate costly illness later, and who in medicine at the pres-

ent plays a more important part than the roentgenological consultant?

It will do no good to call attention to improper conditions, if nothing can be done to remedy them. This is not the case in roentgenology. The first and greatest step for proper medical recognition has already been taken—the organization of the Board of Examiners to pass upon the qualifications of roentgenologists. This will take a little time. Many of the older impressions, as I have stated them, will have to be removed, but in the end the stamp of approval placed upon a man by this Board will be necessary to obtain or keep a position on the staff of an institution. This examining work must be conducted with great care, but the quality of the men thus far appointed to this Board (and I am sure those to be appointed) guarantees this end.

However, along with the standardization of the roentgenologist, along with the attempt to establish the economic side, the demand for qualified men must be met. Proper training should be available. The standard for this training should be set, and the practice of clinics of allowing any physician to remain with them for a few days or months should be stopped. Incompetence, when it exists, must be replaced with competence before we have the right to demand equality with the best. Competent roentgenologists should be available to all.

Some of the work for economic equality has already been done. In Ohio the Industrial Commission of the state has now drawn the line between the expense of operation of the roentgen department and the fee of the roentgenologist, considering the roentgenologist's fee as a consultant's fee, to be paid for as for any other consultation. In Cleveland the Hospital Council, through the efforts of the Cleveland Roentgen Society, has agreed to the same principle in all hospital cases.

Scientific progress in American medicine has been due almost entirely to efforts within the profession. The elimination of the ill-equipped medical school, the standardization of hospitals, the standards of the College of Physicians and the College of Surgeons, all have played their part. We should take the best from the past and perfect our organization in order to make our presence felt, not disregardful of the forces already at work but adding them to our force. To be assured of a just share of the rewards we must bear our share of the burdens. This in the end will react to the advantage of all.

There is yet another problem that confronts us. Again an economic one. The manufacturing of roentgen-ray apparatus is a business. There the ideals of medicine do not touch, but this business is very closely allied to our profession. In the early days the opportunity for profit in manufacturing was small, for the field was limited and the apparatus relatively simple. Now it has grown to a business with millions invested. This business must make a profit, and rightly so, but this profit must come from the roentgenologist. Yet we have no voice in it; we are subject to its dictates. It may falsely spread propaganda about the necessity for this or that, or that this or that is unnecessary. While we may know that both are wrong, we sit idly by or sporadically condemn some small part. No organization has ever taken upon itself to inform other parts of the medical profession, or even the roentgenologists, that these things are against their best interests or the interest of medicine as a whole. Recently business discussions which may cost roentgenologists a large amount of money have been held. We were not consulted and few even here will know to what this statement refers. I maintain we should be heard, that we should be able to speak loud enough for all to hear, and also when heard to be powerful enough to be listened to. All these things can and must be corrected if we are to sustain the second portion of the preamble, "That roentgenology will be maintained as a specialty." And again, I want to say that I believe it should be maintained, and so I make the following recommendations.

1. That the action of the Committee at

Milwaukee with regard to the Examining Board be ratified.

2. That the Junior Membership Amendment be ratified.

3. That a Committee on Economic Relations with Manufacturers be appointed.

4. That steps be taken to change the Constitution so that the dues may be raised.

5. That a permanent secretary be employed, and an organization be established that will look after the roentgenologist's welfare three hundred and sixty-five days a year.

Because it is only by organization and a strong one that most of these things can be accomplished—these things which are vital not only to roentgenology, but to the entire practice of medicine. I realize that anyone who writes of the economic side of medicine immediately leaves himself open to criticism. If medicine could be divorced from economics I would be pleased, but it cannot, so I make no apology, for I feel that the circumstances demand action. The recommendations I have made I deem essential to our future success. Of course we may muddle through, but personally I would rather stride along doing our share to make the future greater than the past.

Some here present will not agree that these problems exist, or some may agree with parts of what I have said. My recommendations may be deemed exorbitant or inadequate, depending upon the point of view. If they have stimulated thought about the future of roentgenology and its relation to the future of medicine, they are justified.

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THE RELATION OF THE AMERICAN SOCIETY FOR THE CONTROL OF CANCER TO RADIOLOGISTS*

By C. C. LITTLE, Ph.D.
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THE relation of the important field of radiology to the work of the American Society for the Control of Cancer is naturally rather a matter of speculation than of scientific exactitude. The opportunity here to present some thoughts on the question is, however, none the less greatly appreciated.

In order to understand the point of view from which the topic will be discussed it will be well to consider, in order, the nature of the work of the American Society for the Control of Cancer as well as the phases of radiology on which it may properly express an opinion.

1. *The American Society for the Control of Cancer*

The Society concerns itself according to its articles of incorporation with the collection and dissemination of information concerning the symptoms, diagnosis, treatment and prevention of cancer.

Clearly from the foregoing statement the work of the Society does not include either experimental research or the support of research on the part of others. It may, however, cover a very wide investigative study of the actual or relative value of various types of diagnoses, treatments and prophylactic procedures. This it would do in order accurately to *collect* information on which more intelligent opinions could be based. Its major duty is thus education. Broadly considered, its efforts in this field should properly include both the profession and the laity.

In order to accomplish its purpose it maintains, by the representative nature of the personnel which makes up its board of directors, contact with many diverse points of view and focal points of interest. It attempts fairly and wisely to balance claims and counter-claims of individuals or groups whose efforts or achievements constitute forces of potential or actual educational importance.

The American Society for the Control of Cancer therefore does not concern itself directly with the research phases of the cancer problem. It tries to act in a judicial capacity—sifting the evidence advanced in any part of the cancer field. On the basis of its best judgment it allows reliable facts to determine or to modify its educational efforts. It tries to be conservative, scientific, impartial and concise in presenting educational material to either the profession or the laity. It does not desire or attempt to produce demands for propaganda in the cancer field. It tries to prevent unnecessary misinformation and sensational attempts to exploit the credulity of the public.

In so doing it in no way exercises or claims to possess inspired or infallible powers of discrimination. It is, however, painfully aware of the unfortunate and obstructional effects on education produced by ill-advised and premature publicity on cancer which so often is featured by the press or by unscrupulous or misguided members of the medical or scientific professions. Because of these and other factors opposed to education it adopts an extremely conservative attitude.

Its aim is to cooperate with existing educational agencies rather than to create new ones. Its objective is to guide rather than to impose a fixed and unalterable point of view, policy, or program upon any group or field.

This attitude is an important one to remember in any such discussion as the present. The Society in approaching the field of radiology desires first of all to obtain a fair and comprehensive picture of the

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

efforts towards diagnosis, treatment and prophylaxis in that field. It then wishes to analyze the facts and from them to pick those that are of educational value. These it attempts to synchronize with the other phases of its educational program. The fact that this program is one of correlation and encouragement of constructive activities already created and maintained by those who are giving their lives to their chosen prefession should always be borne in mind. The converse, namely, that ill-advised and inaccurate activities are condemned is likewise merely a continuation and amplification of the attitude already adopted by the leaders in the various major approaches to the cancer problem. Among these avenues of attack radiology forms, of course, one of the most important and promising.

Because of the unusual strength and potentiality of the psychological factors in the field of cancer the educational problem is and must admittedly continue to be more complex and its technique necessarily more difficult than is frequently the case in more simple, more easily diagnosed and more controllable diseases.

2. *The Field of Radiology*

The field of radiology is comparatively young and is filled with amazing material for sensational and striking items of great news value.

It possesses certain inherent characteristics that render it a potential force of enormous educational and therapeutic possibilities. It is obvious from a study and analysis of its peculiar attributes that radiology is at once a challenge and an inspiration to an organization like the American Society for the Control of Cancer. Radiology possesses unique educational values and as such entails equally characteristic and original treatment and presentation by any society engaged primarily in educational activities.

While it must be admitted that our understanding of the final educational value of the results of radiological research and therapy is not and will not soon be well matured there are certain principles already defined which seem worthy of emphasis before this group. Their successful translation into applied educational procedures depends mainly on the degree to which radiologists will assume a cooperative attitude. There is every reason to expect success in this regard. In fact, there are clear signs that the process of cooperation is already well under way and that it will continue and increase.

Let us briefly consider some of the peculiar characteristics of the field of radiology and attempt to evaluate their educational potentialities. No attempt will be made to present these qualities in order of importance. It must be clearly recognized that they are mutually interdependent.

In the first place, the newness of radiology as a field has already been mentioned. Novelty attracts attention; it has great news value.

Discoveries in radiological theory and technique are thus apt to enlist the selfish interest of the press. Once having done so the urge to publicity by those whose livelihood depends upon the journalistic space obtained is almost sure to prove a disturbing factor of importance. Wise newspaper publicity is a great aid to education but—as before stated—premature or poorly prepared statements are of the greatest danger. It therefore behooves radiologists to exercise extreme caution in allowing journalists access to material which can be used for press articles.

Radiology rests upon a scientific basis, which is characterized by numerous points of contact with other fields of scientific research. The complexity of the physico-mathematical foundation of theoretic radiology indicates unmistakably the need for caution in preventing unskilled writers from presenting any discussion of the speculative or theoretic phases of radiology to the laity. Strange and weird press statements of the action of rays have produced among the general public an almost mystical and supernatural regard for the whole subject.

This, in turn, has led to a blind confidence and trust in radiation which imposes grave responsibilities on those who apply this type of therapy. It means that extreme credulity by the public demands a corresponding duty on the part of the profession to be cautious and conservative. To do otherwise means eventually certain disillusionment and a sudden and perhaps fatal reverse of public confidence and goodwill. Whenever such a reverse occurs its effects reach a far larger circle of people than that formed by those at first concerned. Furthermore, lack of confidence in any one branch of cancer research or therapy spreads like wild fire to the whole field and sets back incalculably the whole cause of education in cancer.

Radiology deals with agents of enormous power. The energy involved is easily although often naturally and inaccurately transmuted by the lay mind to relatively familiar energy units such as those of electricity. This again provides a "sales" argument for radiation as a powerful and therefore respectable agent.

The laity is more or less familiar with some of the practical applications of rays of various sorts. The speed of light, the high voltages of electricity, the energy of cosmic rays are today topics familiar to most readers of the daily press. The idea of wave energy is widespread but an understanding of it is rare and conspicuous by its absence. Little or no discrimination between the relative power of various rays is exercised by either the laity or by the rank and file of the medical profession. The enormous influence of radiation of many sorts upon living tissue is as yet feebly grasped by the laity and is altogether too little recognized and assimilated by the profession itself.

The fact that only relatively recently has anything resembling adequate means of measuring the radiation dosage been devised is worthy of far more weight than is commonly given it. In the past far too many physicists with only an elementary knowledge of living matter or medical men with an elementary knowledge of physics have been allowed to apply radiation therapy. Today there is no valid reason beyond that of inertia which in any way justifies the continuation of such practices. We have learned enough to realize that the interrelation of physics and biology demands in its applied phases a mind or group of minds capable of representing adequately all the constituent elements involved.

The clear evidence that the germ cells and thus all future generations may under certain circumstances be modified by irradiation is also a factor of tremendous seriousness.

When the first statements of this sort were made a somewhat antagonistic reaction on the part of medical radiologists was produced. Some of them marshaled facts to show a large number of instances where no harm was done by irradiation. Others attempted to minimize the importance of the evidence obtained from experimental animals by the old illusory philosophical expedient of emphasizing that man and animals were not identical. As time progressed, however, there has been a steadily increasing willingness on the part of radiologists to welcome the evidence of experimental work. With this has come much more wise conservatism in advocating the use of roentgen rays or radium as means of temporary sterilization or for the treatment of menstrual disorders.

The destructive power of irradiation as well as the growth disturbing and stimulative potentialities possessed by it are therefore weapons of sinister power in unskilled hands.

This is not the time or place to cite instances of this unfortunate procedure. Occasionally an especially flagrant example attracts general attention. Far more often, however, the unfortunate victims of ignorant application of radiation therapy are neither noticed nor recorded. Such abuses form, however, a distinct menace to the much-needed development of radiology. The harm done by them to the individual patient is, from a long time point of view,

small beside the lasting damage which they inflict upon those radiologists and others in the cancer field whose work merits public confidence and support.

The future of radiology thus depends quite as much upon its *wise* development and application as upon its *rapid* expansion in therapy. This is apt to be overlooked both by the commercial groups that derive profit from the increased and uncritical distribution of sources of radiation and by the unscrupulous members of the profession who act as though radiation can be used with the same degree of control and safety as many of the more inert types of therapeutic procedure.

These two abuses form the most serious menace to the progress of any educational program as regards radiology. Recurring cases of tragic results of unwise and unskilled use of radiological agents are certain to produce decreased confidence in the whole field and in the wise and skillful application of radiotherapy. Thus progress is blocked and double harm is done.

Radiology produces in the mind of the average layman a much more pleasant psychological response than does surgery. There is an emotional but entirely human dread of going under the knife. Everything possible is being attempted to dissipate this unfortunate feeling and much is being accomplished. It is, however, certain that treatments with roentgen rays or radium are matters of much more mental comfort to the average man or woman than are surgical operations. They will in all probability continue to be so. This fact imposes upon the radiologist an additional obligation; namely, an unusual degree of confidence on the part of the patient. This must not be abused. It is too valuable a factor both to cancer education and to cancer therapy to fail to protect it by every available means.

The chance of cure of many types of cancer increases directly with the lack of delay in reporting for treatment. Delay is caused not only by ignorance but by fear. The diminution of fear on the part of cancer patients has led to a marked increase in the number of early cases now being reported. Much of this can be credited to the development and spread of non-surgical methods of treatment. As long as such non-surgical methods of treatment such as radium or roentgen rays are skilfully and conservatively applied education will continue to be increasingly effective. The moment, however, that abuses are encountered fear comes back and on its heels stalk delay and death.

The radiologist is thus in a position of *noblesse oblige* as regards cancer education. To the American Society for the Control of Cancer he appears the strongest potential factor in an educational campaign which is sure to be long and slow.

The agents with which he works are of immense power. Their careful control from every angle both in distribution and in utilization is an essential and continuing responsibility. Only by recognizing this fact can the confidence of the public be maintained, the development of cancer education proceed and the increased influence of the radiologist himself be assured.

The relation of the field of radiology to the American Society for the Control of Cancer should therefore be a natural and happy one. Simply outlined, it consists in the recognition by both parties of the great human need of cooperation in the gradual analysis and solution of an enormous educational problem. In this effort success will come only by patience and mutual confidence. The task is important enough to enlist and to hold the sympathetic support of every radiologist and of everyone interested in cancer education.

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LIPIODOL IN BRONCHOGRAPHY*

ITS DISADVANTAGES, DANGERS AND USES

By J. BURNS AMBERSON, JR., *and* H. McLEOD RIGGINS
NEW YORK CITY

SINCE lipiodol and other iodized oils are now being employed so widely for the roentgenographic visualization of the bronchial tree in living subjects, the limitations, disadvantages and potential dangers of the procedure, as well as its advantages, should from time to time be defined more precisely on the ground of accumulating experience. That the lungs usually tolerate the introduction of these oils remarkably well has been demonstrated, but the occasional untoward consequences and uncommon disasters warn against any assumption of assured innocuousness. For this reason the Council on Pharmacy and Chemistry of the American Medical Association[34] has recently urged that the injection of iodized oils into the bronchi or other structures should be attended by every possible safeguard. An experience of six years has taught us how to avoid most of the hazards and how to use the oil to secure the greatest diagnostic information. In general, the guiding principles are clearly understandable.

MECHANISM OF ENTRY, EXPULSION AND RETENTION OF LIPIODOL

Lipiodol, gently poured into the trachea of a quietly breathing person in the erect position, can be seen roentgenoscopically to flow rather promptly into the lower large and medium-sized bronchi where for a time further advance is retarded. If, now, the person hangs upside down over the edge of a bed or table and if he does not breathe forcefully or cough, most of the oil will stream back almost as promptly into the throat and can be expectorated. But, if the erect position is maintained, the columns of oil, possibly including entrapped air bubbles, move in a few minutes into the small bronchi from which also it may be largely eliminated by postural drainage. Independently of posture and gravity some may be regurgitated or coughed up, perhaps aided by contraction of the bronchi. Brauer and Lorey[8] and Jacobeus, Selander and Westermark[20] have studied roentgenoscopically the narrowing of the bronchi, which in some subjects occurs a little while after introducing the oil, and interpret this as due to a tonic reflex contraction of the bronchial musculature. We find no evidence that such contraction is long sustained, but the physiologic variation in the diameter and capacity of the tubes can often be demonstrated by the rise of the lipiodol level in expiration and its fall in inspiration. Once the lipiodol has entered the terminal bronchioles and alveoli, part of it is retained usually for weeks and sometimes for many months. This is a disadvantage, and to prevent it one must understand the factors which cause it.

One factor is the fluidity of the oil. Thin oils penetrate readily and rapidly into the alveoli as we have found by using iodized corn oil. Jacchia[19] has made a similar observation with neo-iodipin. The greater viscosity of lipiodol (iodized poppy seed oil) is therefore an important advantage. Curiously enough, this is often nullified by the practice, advocated by some authorities, of heating the oil to facilitate its injection and to avoid inducing coughing. Bloch[6] has demonstrated how the resulting lowering of viscosity favors rapid and extensive alveolar filling. He finds it best to work with oil at a temperature of 20° to 25° C. (68° to 77° F.), advice which we endorse, having proved to ourselves the wisdom of it during the last two years. In the bronchi, of course, the oil gradually absorbs warmth,

* From the Tuberculosis Service, First Medical Division of Bellevue Hospital and the Department of Medicine, Columbia University, College of Physicians and Surgeons, New York. Presented in abstract before the American Climatological and Clinical Society at Absecon, N. J., May 6, 1932.

but in the interval before the alveoli have become widely filled the roentgenogram can be taken and the patient then immediately inverted for postural drainage.

Another factor of prime importance in this respect is violent respiratory effort such as deep forceful breathing, heaving, and especially coughing. If, with the bronchi of a section of one lung filled with lipiodol, the patient coughs violently, the contrast material can be seen roentgenoscopically to be literally blasted, not only into the immediately tributary alveoli but also into bronchi and alveoli of other sections of the same and sometimes also of the opposite lung. Brown and Archibald,[10] by a most instructive experiment with cats, demonstrated how the force of coughing expels thick, tenacious sputum from the bronchi but exerts an opposite effect on thin fluid material such as pus or lipiodol itself which is actually driven farther into the terminal air passages. The operation of this mechanism undoubtedly helps to explain the propagation of pulmonary infection and to account for some of our unfortunate experiences with lipiodol bronchography described below.

Noting that bronchioles in both the living and dead lung become filled with lipiodol more rapidly than glass tubes of the same diameter, Brauer and Lorey[8] suppose that air may escape through the interalveolar pores from alveoli tributary to the filled bronchi. The resulting vacuum would then actively suck the oil into the bronchioles. This, however, is a dubious theory in view of the known tendency for airless alveoli to collapse and of Van Allen's[39,40] recent experiments on collateral respiration.

The retention of lipiodol, once it enters the alveoli, is due apparently to the ineffectiveness of further coughing, the force of gravity, physical adhesion between the oil film and the alveolar walls and possibly a narrowing of the draining bronchi by tonic contraction and the fixation of the substance by biological processes such as phagocytosis. Why in some cases the retained lipiodol is eliminated in a few weeks and in others not in many months must depend on a number of factors, one of the most important being the depth and extent of penetration by forceful breathing and coughing at the time of filling. The common practice of advising the patient to cough up the material after the bronchogram has been made is reprehensible. Postural drainage *without coughing*, as described below, is the more adequate and safer means of elimination. It is generally known that the oil can be drained more easily from bronchiectatic areas than from healthy sections of the lung, due obviously to the fact that the communicating alveoli have been destroyed or ingress to them is blocked.

FATE OF RETAINED LIPIODOL AND EFFECT ON NORMAL LUNG

By measuring the urinary excretion of iodine Sicard and Forestier[36] in the early days of their work found that as much as 29 per cent of the iodine content of lipiodol injected into the bronchi was finally eliminated through the renal portal. They took this as evidence of "lipodieresis" and absorption by the lung, according to the mechanism described by Roger.[35] They failed to allow for the regurgitation and swallowing of oil which usually attends or follows intratracheal injection, and the resulting intestinal digestion and absorption. Eliminating this source of error and using an oil which may be more firmly bound chemically, Knipping and Ponndorf[22] studied the question and observed no significant absorption from the lungs of man or animals. Grill[16] takes the same view, having found no chemical evidence of lipiodol splitting in the post-mortem study of a lung six months after injection. Even allowing for some slow removal by absorption, it appears that most of the material is discharged through the bronchi and that the failure of this mechanism to operate adequately accounts for the retention in some cases. Occasionally it is possible microscopically to detect oil droplets in the sputum for weeks after the injection.

Apprehension that lipiodol, retained in

the lungs after intratracheal injection, might set up damaging tissue reactions was based largely on the known effect of other oils as found experimentally, for instance, by Waters, Bayne-Jones and Rowntree[41] in 1917 and later by Guieysse-Pellissier,[17] and Corper and Freed,[11] and reported more recently in human beings by Laughlen,[24] Pinkerton[32] and Pierson.[30] Changes in severity varying up to consolidation, caseation necrosis and fibrosis were observed. Pinkerton,[33] however, demonstrated that the type of reaction in rabbits' lungs depends to a great extent on the kind of oil used. Animal and mineral oils provoked considerable inflammation while vegetable oils, including olive oil and lipiodol, caused a relatively mild change. Animal experiments conducted later by others tend to bear out Pinkerton's general conclusion with regard to lipiodol, at least within several months after injection. A study of the reports of Fried and Whitaker,[14] Brown,[9] and Bettman, Kelly and Crohn[4] gives the impression of a consensus among these workers that there is a prompt reaction of the "lining" cells (perhaps with an infolding of these) of the alveoli and that oil droplets may be engulfed by the same cells, some of which accumulate as tumor-like masses in the alveolar spaces. Occasionally some of the oil may enter the capillaries (Fried) or the lymphatics (Brown). Duken and von den Steinen[12] found only an exudate in the alveoli of animal lungs and this was poor or lacking in cellular elements. At the other extreme Brauer and Lorey[8] observed no damage whatever from iodipin (apparently the same as lipiodol) in the lungs of dogs, geese and human subjects. Peiper and Klose[29] alone induced severe pneumonia in two dogs, one of which died twenty-four hours after the injection, the other being killed at the end of nine days. Such varying observations suggest that a number of factors play a part. The chemical makeup of the iodized oil may be one. Sicard and Forestier caution against the use of stale, brownish oil which presumably may contain fatty acids and free iodine. Even fresh oil may contain a trace of free acid (Winternitz;[42] Greenbaum[15]). The kind and age of the animal may make a difference. The amount of oil used and the method of injection (with or without force), the preëxistence of pulmonary inflammation and the possibility of carrying down infectious organisms from the mouth and throat all have to be given due consideration as they may have an important bearing on practical clinical work.

The collective clinical experience of many workers indicates that no serious immediate tissue damage is to be feared from the presence of lipiodol per se in the healthy lung provided certain conditions are observed in the technique. Physiological disturbances, usually mild, may occur, however. We have not seen in healthy persons the development of a roentgenographic lobar opacity which Jacobeus, Selander and Westermark[21] and Pinchin and Morlock[31] have diagnosed as *acute massive atelectatic collapse*, and these are the only reports of the kind we have found in the large literature on bronchography. In Pinchin's case the lobar opacity appeared in the short space of three minutes after the oil injection, and in Jacobeus' 4 cases within ten to fifteen minutes. The amount of lipiodol used bore no apparent relationship to the result noted. The explanation of the occurrence is not very convincing. In the first place there is reason to doubt that the much discussed and variously described condition of so-called massive collapse represents real atelectasis (simple airlessness and collapse of the alveoli) in the strict sense of the word, and the same may be said of the cases of these authors. In many such instances it is more probable that the radiopacity is due chiefly to a rapid flooding of the lobe or lung with transudate (edema). An evidential fact is that most patients expectorate quantities of watery sputum shortly after the "massive collapse." We see this often during and after lipiodol injection, and two of the Jacobeus patients in question raised copious amounts. In his study of the movement

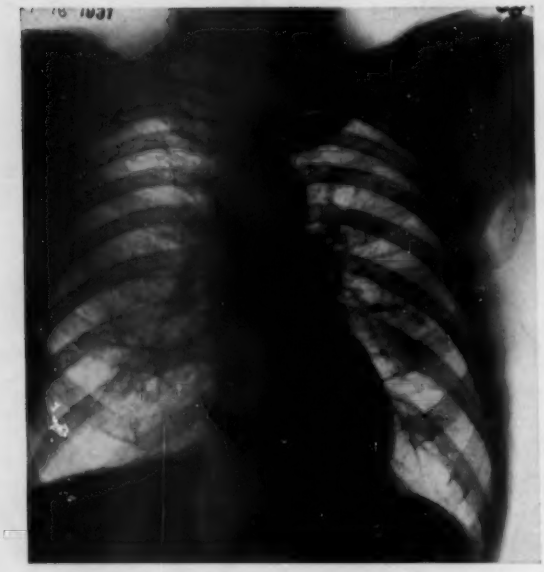

FIG. 1. Case J. B., admitted on account of hemoptysis; râles in right upper lobe.

of body fluid into and out of the lungs, Swindle[38] has shown how delicate is the regulating mechanism and how easily it can be thrown out of balance upon interference with respiratory function. In the light of such knowledge, it is not surprising that even mild irritants such as lipiodol should excite a reaction with edema. As shown by Duken and von den Steinen[12] the edema fluid may occupy only a limited section of alveoli, but under unusual conditions it is conceivable that the reaction might involve much wider sections, thus explaining gross roentgenographic densities. Chevalier Jackson's term "drowning of the lung from within" seems appropriate whether the cause be lipiodol filling or some accident such as abrupt massive pulmonary hemorrhage. In the cases reported by Jacobeus and by Pinchin the roentgen shadows cleared rapidly—easily explainable by the discharge and absorption of the transudate.

Jacobeus and Pinchin suppose that the lobar opacity may represent a collapsed lobe from which the air has been expelled by bronchial spasm induced by the injected lipiodol. This theory is not new and is largely hypothetical. It is known that bronchial contraction, and sometimes severe spasm, attends lipiodol injections. But, while this, together with the obstruction caused by the oil, may at times interfere with proper aeration, it is not clear how this mechanism alone could effect a massive collapse in so short a time.

Whether the retention of lipiodol in the alveoli for years is actually harmful remains in question. The development of foreign body granulations has been strongly suggested in some cases by clinical observation but no one as yet has reported the histological appearance of such a lung.

Diagnostic Disadvantages of Retained Lipiodol. From the roentgenological point of view these deposits are at times a serious disadvantage. In addition to the hard shadows of the lipiodol itself the surrounding alveolar exudate produces a soft perifocal halo. The peculiar lobular shadow, designated by Lenk and Haslinger[25] as a "contrast medium infiltrate" (Kontrastmittelinfiltrate) resembles that of bronchopneumonia except for the dense centers. Later, as the oil is gradually eliminated the fading residual shadows are even more confusing.

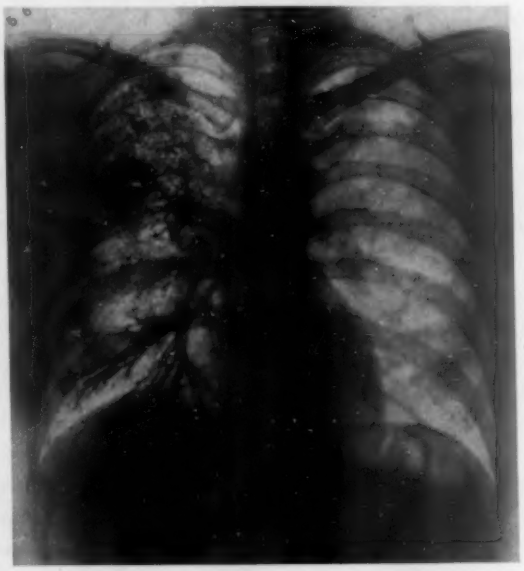

FIG. 2. Lipiodol bronchogram of Case J.B. No definite abnormality of the bronchi. Extensive filling of bronchioles and alveoli in right upper lobe.

Such infiltrates have been mistaken by x-ray interpreters, according to our records, for the following conditions: bronchopneumonia, tuberculosis, bronchiectasis, pulmonary fibrosis, calcified lymph nodes and calcification of the pleura (Figs. 1, 2 and 3). Conversely, in one case of nodular fibroid and calcified tuberculosis the roentgen diagnosis was "retained lipiodol." When associated with the shadows of morbid lesions, these persisting densities are often a great nuisance if one is obliged to lean heavily on serial roentgenograms for the regulation of treatment.

In several cases we have observed an especially confusing roentgen picture, erroneously interpreted as bronchiectasis, produced by the injection of lipiodol by the bronchoscopic method. A pooling of the oil in the pulmonary tissues can be easily created by forceful injection through the bronchoscopic cannula.

DISADVANTAGE AND DANGER OF THE CRICOTHYROID MEMBRANE OR TRANSTRACHEAL METHOD OF INJECTION

Many prefer this method, the needle being inserted directly through the cricothyroid membrane. This technique, or preferably a modification of it described below, is useful in children but it has the disadvantage that lipiodol may escape into the cervical tissues, particularly if the patient resists and moves. Following the fascial planes, the oil may then gravitate into the retrosternal tissues where it remains for years (Fig. 4). In their monograph, Bonnamour, Badolle and Gaillard[7] assemble the published reports of difficulties arising from this cause. These include pain at the site of injection, dysphonia, edema of the glottis, dysphagia, and subcutaneous emphysema. During an injection by the cricothyroid route, Olmer and Zuccoli[28] observed evidence of transitory air embolism in a man of thirty-nine, while Köhler[23] reports mediastinal emphysema and fatal air embolism in a boy of nine. We prefer intro-

Fig. 3. Case J.B. (Oct. 28, 1932). Shadows of retained lipiodol instilled in right upper lobe almost four months previously (lipiodol infiltrate).

Fig. 4. Case S.L. Lipiodol injected by cricothyroid membrane route three years previously. Evidently most of this escaped into the tissues of the neck. Roentgenogram shows lipiodol deposits in the tissues of the neck and also extending low into the mediastinum.

ducing the needle between the cartilaginous tracheal rings. Using this method only in children, we have seen none of the above-mentioned accidents except a little local pain. The danger of escape of infectious material into the neck through the puncture wound is definite, especially when there is copious bronchial discharge. In one of our patients, a child, a phlegmon of the neck developed, and surgical incision was necessary. Bonnamour et al. comment on the rather numerous reports of such infection, some of which are very serious (gangrenous), and cite a fatal case reported by Loederich and another by Comte.

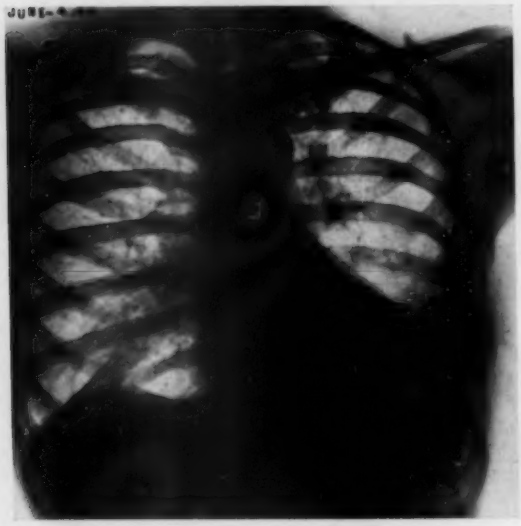

FIG. 5. Case V.P. (June 4, 1930). Tuberculosis in upper and lower one-fourth of left lung; fibrosis at base of right lung.

Excepting contamination with bacteria, lipiodol retained in the tissues of the neck or mediastinum seems to do no harm. Nevertheless, one cannot view with indifference the prospect of indefinite sojourn of the foreign substance which will cast its telltale shadow whenever a roentgenogram of the patient's chest is made.

IODISM

Mild iodism has not been uncommon in our experience. Usually, because of the coryza, tracheitis and low fever, the patient thinks he has caught cold. Only 4 of our patients had slight skin eruptions. As a rule, the symptoms appear in twenty-four hours but occasionally they may be delayed for a few days or a week. The catarrhal symptoms are usually gone within two days. Since iodism is due mainly to intestinal digestion and absorption of the swallowed oil, prevention depends on postural drainage and expectoration of the material immediately after the roentgenogram is made. Assuming that some, nevertheless, may be unavoidably swallowed, it is preferable to carry out the procedure when the patient's stomach is empty and, after postural drainage is completed, to administer orally a dose of Epsom salt. It is then unnecessary to wash the stomach or to give a preliminary test dose of potassium iodide as advocated by some.

The chief dangers from lipiodol instillation into the bronchi by any method fall into two general classifications, viz., those traceable to dissemination or aggravation of infection, and those depending on a mechanical or physiological disturbance of the respiratory or cardiorespiratory function.

Fig. 6. Case V.P. (Nov. 10, 1930). Shadows of lipiodol retained in the alveoli of the middle and previously healthy section of the left lung.

DISSEMINATION AND AGGRAVATION OF INFECTIOUS PROCESSES IN THE LUNGS

Using care to avoid carrying down contaminated secretions from the mouth and throat, we have never been able to trace infection of a previous healthy lung to lipiodol injection. However, if the bronchi or lungs are already diseased, as they usually are in cases selected for this procedure, the hazards are real, and we have a number of unfortunate results to report.

Dissemination of Tuberculosis. The first case illustrates the rapid spread of pulmonary tuberculosis following the intratracheal instillation of lipiodol.

Case V.P. A negress, aged thirty-one, entered a state sanatorium, June 4, 1930, on account of tuberculous infiltration with several small cavities in the upper and lower quarters of the left lung and fibrosis at the base of the right (Fig. 5); evidence also of a mitral valvular heart disease. She raised half an ounce of sputum

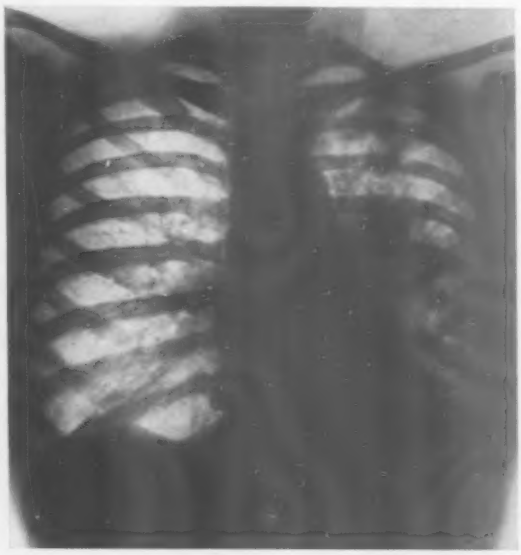

Fig. 7. Case V.P. (Nov. 28, 1930). Acute spread of tuberculosis in the middle one-third of the left lung where lipiodol was retained. Disease progressed rapidly after this.

daily, and this contained tubercle bacilli. Because of recurrent attacks of dyspnea and wheezing, lipiodol was instilled by the transglottic method mainly into the bronchi of the left lung, September 6, 1930, in an attempt to demonstrate a suspected obstruction, but none was found. The roentgenogram of October 25, 1930, shows retained lipiodol (lipiodol infiltrate) in the middle third of the left lung and a slight increase of the tuberculous process in the upper third. On the same day lipiodol was again injected, and the roentgenogram of November 10 (Fig. 6) still shows many retained lipiodol deposits in the lower two-thirds of the left lung. The patient improved, gained 7 pounds and rarely had a temperature above 99.6° F. until the date of her discharge, November 20, 1930. Four days later, on entering Bellevue Hospital, she was greatly prostrated, had nausea and vomiting and paroxysms of dyspnea which we attributed largely to the heart disease. Blood Wassermann negative. Blood leucocyte count, December 4, 10,000; 71 per cent polymorphonuclears; 26 per cent lymphocytes. The sputum increased and the temperature rose to 102° or 103° F daily. A roentgenogram (Fig. 7) demonstrated a rapid spread of the tuberculous infiltration in the middle third of the left lung, a previously clear region where the lipiodol was mostly retained. The patient left the hospital December 21, 1930, and died March 19, 1931.

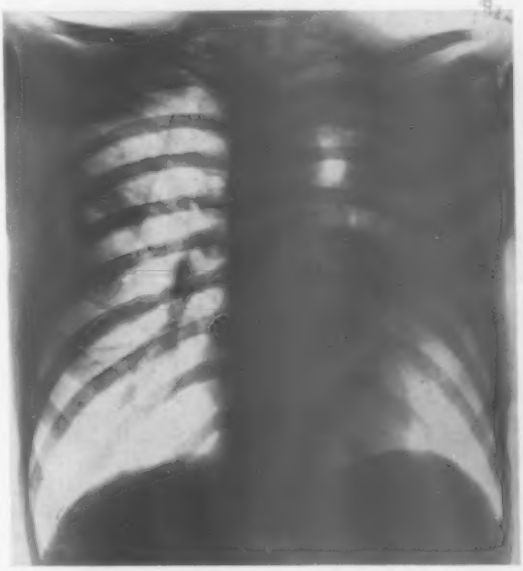

Fig. 8. Case T.A. (July 25, 1927). Large lung abscess in the upper two-thirds of the left lung; lower one-third clear.

We have a second case (E.E.) previously

FIG. 9. Case T.A. (Oct. 11, 1927). Cavity now appears in the abscess region. Lipiodol retained in the lower and healthy portion after bronchoscopic injection.

treated and erroneously diagnosed as bronchiectasis elsewhere, in which there was an acute spread of tuberculosis throughout the left lung following repeated bronchoscopies and injections of lipiodol.

Extension of Lung Abscess. The following case of Dr. Helen Gavin demonstrates the acute spread of lung abscess into healthy lung tissue in which injected lipiodol was retained, with a fatal ending.

CASE T.A. A white woman, aged eighteen, with a post-tonsillectomy lung abscess in the upper part of the left lower lobe (Fig. 8), admitted to another hospital, July 22, 1927. Bronchoscopy was performed on August 5, and lipiodol was injected into the left lung for diagnostic purposes. Part of this was retained in the alveoli of the lower and apparently healthy section. Expectoration of much foul sputum continued, lipiodol was again injected bronchoscopically, October 11, and again some of it was retained in the same region (Fig. 9). Here, attended by persisting expectoration and an exacerbation of fever, a secondary abscess rapidly developed to be followed by the appearance of sacculated empyema at the same level (Fig. 10). On December 23, parts of the seventh and eighth ribs were resected posteriorly, the empyema was evacuated, and the lower lobe was seen to be consolidated and probably gangrenous. The patient died on January 9, 1928.

In another case (J.C.), a Polish laborer, treated at Bellevue Hospital in 1927 and 1928 for a chronic abscess of the lower lobe of the left lung, we believe that the injection of lipiodol through the bronchoscope may have accelerated the spread of the disease.

Comment. The spilling of infectious discharges through the bronchial tubes from ulcerating or exuding cavities or bronchi into previously healthy regions of the lungs is one of the common modes of spread of previously localized tuberculosis or nontuberculous suppurative disease. The hazard increases as the discharge becomes more copious and more fluid, as, for instance, in hemorrhage. The admixture of additional fluid, such as lipiodol, might be expected, therefore, to provide a more facile vehicle for the transport of infection. In the cases cited strong evidence of this is the undoubted development of new secondary le-

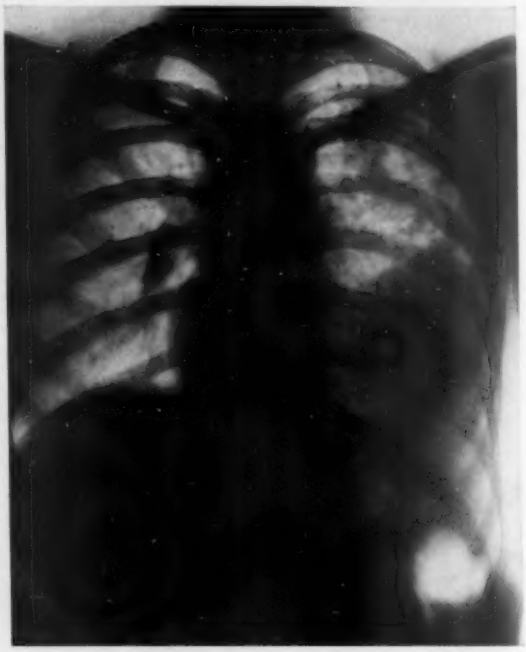

FIG. 10. Case T.A. (Dec. 12, 1927). Secondary abscess and sacculated empyema at the site of retained lipiodol which can still be seen indistinctly.

sions in apparently healthy parenchyma to which the oil flowed. The reasonable inference is that bacteria-laden pus or mucopus from existing lesions mingled with the oil, gravitated with its stream and lodged with it for a sojourn of days or weeks in healthy alveoli. More favorable conditions for the genesis of new lesions here could hardly be imagined. A similar view of this mechanism is entertained by Grill,[16] Archibald and Brown,[3] and others, although, as mentioned by the latter, the clinical evidence reported up to 1927 was scanty. Since our selection of cases and technical procedures have been modified on the basis of this knowledge we have had no more accidents of this kind.

Aggravation of Chronic Suppurative Pneumonitis; Questionable Atelectasis; Acute Pneumonia; Fatal Hemoptysis. Chronic indurative and suppurative pneumonia, often with bronchiectasis, is a well-known clinical picture. Attacks of fever and increased local symptoms usually signify exacerbations of acute or subacute bronchopneumonia, and this, or some other alarming episode such as hemoptysis, often brings the patient to the hospital. If lipiodol is introduced into the bronchi during one of these phases of active inflammation, there is danger of aggravating the process. This may be slight or serious; transient or progressive. As a sequel, secondary complications, such as pleural inflammation or hemoptysis, may occur. The following cases serve to illustrate.

Case C.R., a white woman, aged thirty, with symptoms of pulmonary suppuration of four months' duration. On admission, June 8, 1932, the whole right lung was involved in the chronic pneumonia and bronchiectasis. For three months she was treated by bed rest, postural and bronchoscopic drainage. The temperature ranged from 98° to 102° F., and the foul sputum amounted to 5 to 12 oz. daily. On September 8, during a partial remission of symptoms, lipiodol was instilled by the supraglottic method into the bronchi of the right upper lobe. Following this, the temperature gradually rose and the serial roentgenograms showed a persistent clouding of the right upper lobe, interpreted as increased inflammation. This did not subside and, while the prognosis was always considered hopeless, the reaction contributed somewhat to the later unfavorable course. The patient died December 29, 1932. Autopsy confirmed the clinical diagnosis.

Case F.G., a white girl, aged fourteen, admitted April 11, 1931. History of recurrent bronchitis with fever since infancy and of chronic cough with 2 oz. of thick greenish, slightly foul sputum since an attack of pneumonia seven years previously. A diagnosis of chronic bronchiectasis of the right lower lobe was made. Lipiodol was injected bronchoscopically into the bronchi of this lobe, April 29, 1931. The bronchogram showed saccular bronchiectasis. A roentgenogram eight days later, revealed a triangular opacity at the base of the right lung in addition to retained lipiodol. Since a chronic inflammation of this type usually results in shrinkage of the affected lobe, the density in question was interpreted as a retention of oil and secretions in the right lower lobe; this seemed to impede proper aeration and there is possibly an element of atelectasis in the picture. The clinical condition was not disturbed and the roentgenographic density gradually cleared during the subsequent five weeks.

Case D.C., a Porto Rican, male, aged twenty-four, admitted August 17, 1931. Had been in the hospital twice during the previous year. His complaint was the spitting of 2 oz. of blood on each of three occasions, slight cough and slight pain in the left chest. In the hospital his general condition was very good and the only significant symptom was the expectoration of a small amount of mucopurulent sputum, sometimes blood-streaked. There was marked splenomegaly, and old scars on the legs suggested lues although the blood Wassermann test was negative. Physical and roentgen examination showed light fibrotic infiltration of the left lung but no cavity; many small râles throughout. The right lung was clear. Tubercle bacilli could not be found in the sputum, and bronchoscopy was negative. Suspecting the possibility of bronchiectasis, a lipiodol bronchogram was made in July, 1931, but this showed no abnormality. The bronchogram was repeated, September 3, 1931, about 10 c.c. lipiodol being instilled by the supraglottic method so that some entered the descending bronchi of

both lungs. The temperature, previously normal, rose to 100° F. during the next few days; starting September 11, it became more elevated each day until it reached 105.8° F. September 14. Then it slowly receded and did not rise above 100° F. from September 21 until October 7, when the patient was discharged. At the height of the fever, signs of dullness, bronchial breathing and many moist râles were elicited over the left lower lobe, and the roentgenogram of September 16 showed the density of acute pneumonia in the lower half of the left chest. The blood leucocyte count, September 17, was 16,200. During the attack and its recession the sputum was copious, mucopurulent and slightly foul. The last roentgenogram of September 26, showed much clearing but this was not yet complete.*

CASE J.L. The patient, a white man, aged fifty, was in the hospital from September 23 until October 11, 1930. He was considered to have chronic pneumonitis and bronchitis with a recent exacerbation of bronchopneumonia in the left lung. The sputum was occasionally blood-streaked but not foul. The temperature ranged up to 101.4° F. Before the acute inflammation had completely subsided lipiodol was instilled into the left lung. No bronchiectasis was demonstrated and the patient went home the following day, October 11. Four days later he returned with a temperature of 103° F., increased cough and expectoration, and pain in the chest. He was found to have bronchopneumonia on the left; and a small amount of reddish fluid was aspirated from the left pleural cavity. Almost the entire lung became consolidated as shown by physical and roentgen examination. There was no empyema; 25 c.c of thin reddish fluid, aspirated from the left pleura, November 11, yielded no growth on culture. The white blood count, October 15, was 21,000, 90 per cent polymorphonuclears; October 16, 13,500, 84 per cent; November 11, 10,600, 82 per cent. The patient's condition became steadily worse and he died November 17.

CASE S.C., admitted August 28, 1929, a white man, aged forty-nine, who fell sick in July with a profusely productive cough and loss of weight and strength. On admission he was coughing up about 9 oz. of slightly foul, sweetish smelling, mucopurulent sputum daily. The diagnosis was suppurative pneumonitis at the base of the right lung, possibly with bronchiectasis. Bronchoscopy, September 20, showed pus coming from the right middle and lower lobe bronchi. The temperature varied from 97° to 100° F. On September 25, about 20 c.c. lipiodol was instilled by the supraglottic method. Most of this entered the right lung but a small amount went into the left lower lobe also. No bronchiectasis was demonstrated. After this there were occasional rises of temperature up to 101.8° F. On October 11, he had marked dullness, bronchial breathing and numerous râles at the posterior base of the right lung and similar but less marked signs at the left base posteriorly whereas, on admission, only slight bilateral basal dullness and a few râles at the right base were elicited. The roentgenogram of October 22 shows a good deal of retained lipiodol at the right base, with a surrounding exudative reaction; also a suggestion of diffuse inflammation at the left base. The sputum continued to be foul and copious. The evidence was interpreted as indicating an acute exacerbation of the suppurative pneumonia. On the night of October 28, the patient had a sudden paroxysm of coughing and a hemoptysis of 2 oz. He lost consciousness immediately and died within an hour. Apparently, the immediate cause of death was the inundation of the lungs with blood, most of which could not be expelled.

In our series there is another case in which extensive saccular bronchiectasis of the right lower lobe was proved and in which lipiodol instillation was possibly a factor in aggravating the suppurative process, thus precipitating a large hemoptysis. This was controlled and the affected lobe was later removed surgically.

Comment. With the evidence of these cases, there can be no doubt that instilled lipiodol may precipitate a more or less acute inflammatory reaction in an existing suppurative lesion and probably in other smoldering infections as well. We are among those who suspect that this pneumonic complication is a more common experience than the literature reveals. According to Morvay[27] who discusses the question, Piccenino, in 1927, was the first

* Later, in another hospital, another lipiodol bronchogram was made. On August 22, 1933, the patient returned to Bellevue with definitely active tuberculosis in both lungs, and he died from this September 15, 1933. The autopsy revealed fibroid tuberculosis of the left upper lobe with cavity, extensive tuberculous excavation of the left lower lobe and fresh bronchopneumonic lesions in the right lung. The case is recorded because of the pneumonia following lipiodol instillation which apparently had no relation to the subsequent activation of the tuberculosis.

to report a case. It is also considered seriously by Bonnamour, Badolle and Gaillard and by Archibald and Brown. The latter have presented a most helpful paper on such dangers and suggest that these are explainable on the basis of several factors—plugging of small âir passages and interference with drainage, retention of lipiodol with resulting congestive reaction, and carrying down of additional infection from the mouth or throat. The first two of these seem to be the more important. Once initiated, an inflammatory reaction may be uncontrollable, as shown by our fatal cases. The fatal hemorrhage in Case S.C. most probably was due to rapid pulmonary necrosis and ulceration. Forestier and Quentz[13] observed a similarly fatal hemorrhage, and Grill[16] had a patient with bronchiectasis who died from an acute suppurative process following lipiodol instillation.

Incidentally, lipiodol does not possess sufficient antiseptic power to stop the growth of bacteria in the lung. Neuswanger and Brown (cited by Archibald and Brown) showed this. Amako[1] found that 20 per cent iodipin exerts no significant lethal effect upon tubercle bacilli in the test tube, and kills pyogenic and intestinal bacteria only after many hours of contact. Forestier and Quentz hold a somewhat similar view, but on the basis of experiments with rabbits think that the antiseptic action may be greater in the living subject.

Prevention of serious consequences of oil injection depends on strict regulation of the procedure as we are discussing below.

DANGERS FROM INTERFERENCE WITH CARDIAC AND RESPIRATORY MECHANISMS

Cardiac Weakness. In patients in whom myocardial weakness from any cause is apparent or suspected, the bronchial instillation of lipiodol may cause dyspnea. In 3 such cases, known to us, this symptom was somewhat alarming.

Pulmonary Fibrosis and Emphysema. Cases of pulmonary fibrosis and emphysema, often associated with a secondarily overtaxed heart, may react in the same way. In this category we have one fatality to report.

Case J.W., admitted December 1, 1931; a white man, aged sixty-four, who complained of dyspnea of two years' duration, becoming worse of late. He had lost 30 pounds in weight, had had occasional attacks of vertigo and fainting during the preceding three weeks, and felt weak. He had had hay fever for many years,

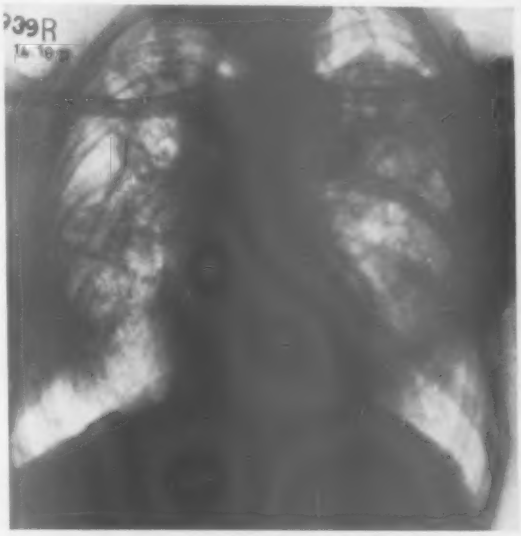

Fig. 11. Case J.W. Advanced bilateral pulmonary fibrosis and emphysema and possible bronchiectasis.

sinusitis forty years previously, and rheumatic fever in childhood, and drank alcohol to excess. On admission he appeared undernourished and chronically ill, and was slightly dyspneic and cyanotic. The chest was barrel-shaped and revealed these other signs: Right—Slight dullness throughout. Breath sounds harsh just below the clavicle. Many crepitant and a few moderately coarse râles throughout. Left—Slight dullness and crepitant râles in the middle third. The roentgenogram of December 11 (Fig. 11) showed widespread bilateral pulmonary fibrosis and emphysema associated with more or less round rarefactions varying up to 5 cm. in diameter which suggest bullous emphysema and possibly some bronchiectasis. The heart seemed slightly enlarged to the right, and the sounds were distant. The brachial arteries were moderately sclerotic and slightly tortuous. The liver was not enlarged but its lower border was

palpably irregular, hard and slightly tender. The fingers and toes were clubbed. The sputum was mucopurulent, about 2 or 3 ounces daily and negative for tubercle bacilli. The urine showed a trace of albumin and a few hyaline and granular casts. Analysis of the blood serum showed 33 mg. nonprotein nitrogen, 15.6 mg. urea nitrogen, 1.4 mg. creatinine, and 87 mg. glucose in 100 c.c. The temperature fluctuated from 98° to 101° F., but this and the dyspnea, as well as the general condition improved markedly after three weeks' rest in bed. On December 24,

FIG. 12. Case J.W. (Dec. 24, 1931). Roentgenogram made after the patient had collapsed and died following the instillation of lipiodol.

in preparation for a bronchogram, the patient was given a postural drainage, and the following medication (a much heavier dosage than we are accustomed to give) was administered on the order of the house physician: sodium amytal gr. 3, by mouth; codeine sulphate, gr. 1½, and atropin sulphate, gr. 1/33, by hypodermic. An hour later the house physician took the patient, who was sleepy, in a wheel chair a short distance to the roentgen room, where the pharynx was sprayed with 4 per cent cocaine solution and between 5 and 10 c.c. lipiodol was instilled by the supraglottic drop method into the bronchi. The patient then stood before the roentgenoscope and in a few minutes collapsed. The pulse was irregular and weak, and the patient became very cyanotic and dyspneic. The administration of stimulants and oxygen inhalations did not help, the pulse became very slow and weak and, without regaining consciousness, the patient died within an hour. A postmortem roentgenogram showed scattered lipiodol shadows in both lungs (Fig. 12).

Comment. A combination of factors was responsible for this patient's death. Under rest treatment his failing heart had regained itself somewhat but obviously not sufficiently to withstand strain. While the preliminary medication was given in large doses this did not seem to be the lethal factor. The exertion attendant on lipiodol instillation and roentgenoscopy must have been too much. Finally, the respiratory surface, already greatly diminished by extensive fibrosis and emphysema, must have been further depleted by the oil filling some of the bronchioles. In our judgment, the heart failed from these causes.

Asthma and Asthmatic Bronchitis. Disturbing effects have been noted by us in patients with asthma and asthmatic bronchitis. R.K., a woman, aged twenty-nine, with chronic asthmatic bronchitis and emphysema had a severe paroxysm of dyspnea and wheezing after the instillation of only 2 or 3 c.c. of lipiodol into the trachea. G.T., an outpatient, a girl, aged seventeen, who had had asthma and bronchitis since childhood resulting in the development of moderate pulmonary emphysema, experienced a similar immediate attack with low fever during two days after the instillation of 10 c.c. of lipiodol.

Comment. Since, in allergic persons, an asthmatic attack may be provoked at times by indifferent as well as specific agents, it is reasonable to expect that with iodized oil instillation severe bronchospasms might be induced. Complicating emphysema and chronic catarrhal inflammation may perhaps heighten this tendency. While the consequences may not be serious, the fatality reported by Macdonald[26] indicates at least that potential dangers must be recognized.

This was the case of a thirteen-year-old girl, who experienced nausea and vomiting after the lipiodol injection, became cyanotic and weak-pulsed and died in twenty hours. Commenting, Macdonald says: "This child had suffered from asthmatic attacks for many years, and it should be noted that sensitization tests, carefully carried out, indicated that she was hypersensitive to several types of allergens. In conformity with this, it is a reasonable conjecture that her death was due to an allergic reaction to lipiodol." It is probable that the pleural fibrosis and the chronic pulmonary and bronchial changes, as well as the congestion, edema and tenacious bronchial secretion found at autopsy contributed to the final disaster. Anderson,[2] on the other hand, reports treating 100 cases of bronchial asthma by intratracheal injections of lipiodol, usually with ultimate benefit. He advises caution, however, since in some of his cases the first injection precipitated an immediate attack. In others "there are certain untoward reactions characterized by pain, pressure and temperature."

Bronchial Occlusion. In a number of cases in which a bronchus was occluded by a growth we have used lipiodol for bronchography. Cautiously instilling less than 10 c.c. we have observed no ill effects. Singer[37] of Vienna, however, reports a fatality in a case of carcinoma of the right lower lobe bronchus and compares it with a similar accident reported by Trommer. Singer considers the part that might have been played by the anesthetic, but believes that the manner of death most strongly suggests suffocation. It is, indeed, easy to visualize this. If the ventilation of one or more lobes is already reduced or prevented by such an obstruction, the introduction of oil into functioning bronchi must certainly further deplete the respiratory surface, and if this is sudden and extensive beyond physiological limits, the symptoms of Singer's patient—shock, tonic and clonic convulsions, intense cyanosis, dyspnea, unconsciousness and death—might be expected as evidence of acute asphyxia.

USES OF LIPIODOL FOR BRONCHOGRAPHY

In spite of these disadvantages and dangers, the procedure is still to be regarded as an invaluable aid for the diagnosis of various chest conditions. By attempting, as we have done above, clearly to visualize the causes and mechanisms of possible accidents we can with assurance of great success adopt means to avoid most of them. In fact, during the year 1932 and thus far in 1933, we have had no serious accidents or complications and no fatalities from this cause. Without discussing details of lipiodol bronchography which are familiar parts of the literature on the subject, we shall present briefly the general principles governing selection of cases and technique which we have tested and found sound.

Primarily it is important that the case have a thorough preliminary clinical study. This includes, in addition to the history and physical examination, roentgen examination of the chest, repeated sputum examinations with concentration methods, and in some cases bronchoscopy. As a rule, it is much better for the patient to enter the hospital for such study. For this reason and because of occasional untoward reactions the procedure cannot be used as freely in the outpatient clinic or the private office.

The clinician, who has studied the case and knows specifically what further information is needed, should perform the lipiodol instillation or at least closely direct it. There is, of course, no reason why a laryngologist or any other qualified physician should not do this if he works with full understanding of the individual problem, but the procedure certainly does not belong exclusively in the "nose and throat" specialty. Our practice is to train all our resident physicians to perform their own lipiodol instillations.

Bronchography should be done when it is important to verify the clinical diagnosis, to supplement it with additional information, or to make a diagnosis which may be surmised but impossible to establish otherwise. From 3,500 to 3,800 patients pass through our ward service in Bellevue Hos-

pital each year. About 80 to 85 per cent of these are tuberculous, the remainder being grouped under a large variety of diagnoses. Lipiodol bronchography is performed in less than 1 per cent of the tuberculous cases and in 10 to 15 per cent of the nontuberculous ones.

Bronchiectasis. In this condition the diagnostic use of iodized oil is of greatest importance. When the clinical picture is definite, bronchography is of service in accurately fixing the site and extent of the involvement. In treatment this information is advantageous, and, if the treatment is to be surgical, quite indispensable. If, for instance, the surgeon contemplates lobectomy, accurate localization of all the main ramifications of the disease is fundamental to a decision.

For the diagnosis of "dry," sometimes hemoptoic forms of bronchiectasis, lipiodol bronchography possesses a unique advantage, as first shown by Bezançon and his coworkers.[5] These patients have only a small amount of mucoid, slightly foul or odorless sputum, sometimes intermittently, or none at all. Some come to the hospital because of hemoptysis, which may recur at intervals of months or years. First of all, tuberculosis must be ruled out. The roentgenogram usually is clear or only suggests some fibrosis. Then, bronchography may demonstrate a well-marked, usually cylindrical bronchiectasis which gives rise to no definite physical signs or perhaps just a few localized râles most often at the base of a lung. Before the use of bronchography, these patients were often thought to have "occult tuberculosis" and many spent months "curing" in sanatoria. Some, unfortunately, still do.

Lung Abscess. As illustrated with case reports there is an element of danger in introducing lipiodol into the bronchi in the acute stage of lung abscess. Because of occluding edema or granulation the oil may fail to enter and delineate the abscess. It is rarely, if ever, necessary to resort to bronchography for the diagnosis of this condition, and, once diagnosed, the abscess can usually be localized accurately by other clinical and roentgen methods. In the healing stage, however, when the acute inflammation has subsided and the abscess has "dried up," leaving only some fibrosis, lipiodol may be introduced with safety and advantage. In this way we have found residual cavities or bronchiectasis in some cases in which symptomatic healing was complete following medical or surgical treatment and in which other physical and roentgenological methods of examination gave little or no clue to the presence of these remnants. Such information is of importance in helping to determine what advice should be given the patient about his future course.

Bronchial Tumors. Neoplasms springing from small bronchi or situated in upper lobe bronchi are often not visualized by the bronchoscopist. Occasionally, in such cases a lipiodol filling defect has given us our first proof of a bronchial obstruction. The accidental discovery of such a defect in 2 of our cases previously considered to be bronchiectasis resulted in the finding of carcinoma. Coating the trachea and bronchi with the oil has proved helpful at times in determining the location and degree of distortion and compression from the pressure of extrinsic tumors such as retrosternal thyroid and aneurysm.

Tuberculosis. In a very few cases of tuberculosis bronchography may be indicated. Thus, in clinically healed disease with persisting sputum and possibly slight blood-spitting, the procedure may demonstrate complicating bronchiectasis. This is more common in extensively fibroid tuberculosis, and the dilated bronchi are sometimes visualized with the oil even after thoracoplasty. Some employ the method to prove the presence of and outline cavities otherwise hidden by surrounding fibrosis and thickened pleura. But the occasions for this need are few indeed. If ordinary physical and roentgen examination do not suffice for the purpose, stereograms, oblique and lateral roentgenograms, sometimes taken with a screen grid, roentgenoscopy, and possibly a diagnostic pneumothorax or

bronchoscopy usually yield all the information that is required for diagnosis and for the various forms of therapy, especially collapse treatment—and without the hazard that attends the instillation of oil. Almost all workers are agreed that the oil should not be used in febrile or hemoptoic stages of tuberculosis. We go further and, for reasons stated, warn against its use in any of the exudative or caseating forms of the disease, particularly if there is much sputum. It is relatively safer to use it in the fibroid or fibrocavernous forms if the sputum is scanty or does not contain tubercle bacilli.

Miscellaneous Uses. Occasionally we have found lipiodol roentgenograms of value in distinguishing extrapulmonary from pulmonary collections of fluid or gas. In several cases it has helped to identify the site and presence of bronchopleural fistulas. It is often useful in tracing the course of other sinus and fistulous tracts. For instance, we had a case of upper thoracic spinal caries with an abscess presenting an opening in the anterior cervical triangle. After injecting lipiodol into this fistula to determine the extent of the abscess cavity, the roentgenogram showed deposits of the substance in both lungs, proving an unsuspected communication with the trachea or bronchi.

Special Contraindications. On the evidence presented we consider it bad practice to instill lipiodol into the bronchi of patients who have obviously weak myocardiums because of the dyspnea and pulmonary edema which may result. In patients with extensive emphysema and pulmonary fibrosis it should be used with great caution, and not at all if there has been evidence of secondary cardiac failure. Asthmatics, particularly the chronic ones, should be managed carefully; as a rule we try to get along without bronchography in these cases. In any case, the presence of an acute or subacute inflammation of the lungs or bronchi, with or without fever, is a contraindication and the procedure should be postponed until the inflammation has subsided. In cases of hyperthyroidism iodized oil probably should not be used since the iodine, liberated from the swallowed oil, may do harm; brominized oil has been advised by some as a substitute. At all times the selection of cases should be guided by discretion and judgment with regard to the patient's general condition and individual peculiarities.

TECHNIQUE

We describe here only the methods which we have used. They are simple and satisfactory. There are numerous modifications recorded in the literature.

Preparation of the Patient. An hour before introducing the lipiodol it is advantageous in most cases to give by mouth codeine sulphate, gr. ½ to 1, and sodium amytal, gr. 3. Occasionally, atropine sulphate, gr. 1/100, may also be given if the bronchial secretion is profuse. With this preliminary medication the patient is quieter and less likely to cough, and the flow of oral and bronchial secretions is inhibited. To guard against the aspiration of infectious material from the mouth, the patient should brush his teeth with sodium perborate or some other suitable preparation. If the amount of sputum is considerable, and especially if it arises from a lesion in the lower part of the lungs, the patient should drain his bronchi by hanging over the edge of a bed or table, head and shoulders down, for ten to twenty minutes. This clears the passages for better lipiodol filling and helps prevent coughing and overflow of infectious secretions into healthy sections of the lungs during such filling. The actual injection is best done in the roentgen room so that it can be controlled roentgenoscopically and roentgenograms can be taken immediately. Transporting the patient to the roentgen department after the injection and allowing more than a few minutes to intervene before the roentgenograms are taken is almost sure to impair the quality of the bronchograms because of the scattering and too deep penetration of the oil.

Topical Anesthesia. With the preliminary medication suggested it is sometimes un-

necessary to anesthetize the throat, but we find it more satisfactory as a rule to do so. The pharynx and anterior faucial pillars are sprayed lightly with a 4 per cent aqueous solution of cocaine hydrochloride, and, if the upper third of a lung is to be injected, the larynx also is so anesthetized.

FIG. 13. Position of the patient for lipiodol filling of the right middle lobe.

Temperature of the Lipiodol. Heating the lipiodol above body temperature lowers its viscosity and makes the injection easier for the operator, but there are objections to this. A very freely flowing oil enters the pulmonary alveoli more readily, thus tending to obscure the roentgenographic distinctness of the bronchi. Furthermore, oil in the alveoli is not easily expelled and may remain trapped there indefinitely, a disadvantage discussed above. It is better, therefore, not to heat lipiodol, as is often done, but to use it at a temperature of 65 to 75° F.

Section to be Injected; Amount of Oil. As a rule, it is advisable to inject only one lobe or section of one lung at a sitting, since this helps to avoid accidents. Further, if bronchi of both sides are injected simultaneously, it may be difficult or impossible to obtain readable lateral and oblique roentgenograms. For a lower lobe 10 to 20 c.c. of lipiodol suffices, and for the upper third of a lung, 10 to 15 c.c. If stenosis of the trachea or bronchus is suspected only about 5 c.c. are directed to the point in question by carefully posturizing the patient. It is always good practice to use the smallest quantity of oil adequate for the desired result. Sometimes a mere coating of the air tubes is enough.

Injection by Oral or Supraglottic Route. Lower Parts of the Lung. The patient sits on a chair, leaning one way or another according to the lobe to be injected. For the right lower lobe he leans backward and to the right; for the right middle, forward and to the right (Fig. 13), and so on. Holding the patient's tongue the operator slowly injects the oil with a syringe attached to a curved laryngeal cannula, the tip of which is held above or just behind the epiglottis. Meanwhile the patient is instructed to breathe naturally.

Upper Parts of the Lung. The patient lies on a table on his affected side. The shoulder is lowered so that the apex of the lung is dependent, and, with the lowermost forearm flexed, the patient props his head in his hand. With his free hand he grasps his tongue in a piece of gauze and holds it out. With the patient's neck bent toward the unaffected side, the operator, with the aid of a laryngeal mirror, places the tip of the cannula in the larynx and injects the oil quite slowly (Fig. 14). The patient continues to lie with his shoulders dependent, so that the oil does not flow into the lower

FIG. 14. Position of the patient for lipiodol filling of the right upper lobe.

bronchi; he rolls to the desired position and the roentgenograms are made. Afterwards it may be useful to have a roentgenogram with the patient in the erect position also.

Roentgenoscopy and Roentgenography. It is usually advisable to roentgenoscope immediately to ascertain roughly the extent of the filling. Roentgenograms are then made, employing a very long exposure or deep penetration in order to yield maximum visualization of the contrast material. Since a long time exposure may lead to blurring from motion, the roentgen tube may be moved close (24 inches target-film distance), thus shortening the time and increasing the penetration. Lateral views are also made to localize the injected parts more accurately; sometimes oblique views too. Stereograms may be made but we find posteroanterior, lateral and oblique views more serviceable. The use of a Potter-Bucky diaphragm, of course, makes for distinction and sharp contrast.

Emptying the Bronchi of Lipiodol. During

Fig. 15. Case S.D., admitted for chronic cough and expectoration; previous history of pneumonia; moderately coarse râles in right upper lobe; no evidence of tuberculosis.

the foregoing maneuvers it is important for the patient to restrain coughing or other violent respiratory effort. After the roentgenograms are made the patient hangs over a table to drain his bronchi, *without coughing.* Most of the oil will flow out in ten or

Fig. 16. Case S.D. Lipiodol bronchogram showing bronchiectasis in the right upper lobe. Bronchogram of lower lobes of both lungs showed no abnormalities (see Fig. 14).

fifteen minutes. For reasons discussed the importance of this postural drainage cannot be stressed too much.

Transtracheal Route. In young children and occasionally in older persons the oral route of oil instillation is impractical or intolerable, and the lipiodol may be injected by means of an 18-gauge needle inserted in the midline of the neck between two of the upper tracheal cartilages according to a method suggested by Heuser.[18] The patient is prepared as described above and is placed on his back on a table, a rolled pillow beneath his neck and his head extended over this. Care should be taken to prevent the escape of lipiodol into the cervical tissues. This is facilitated by entering the trachea with a needle and syringe containing novocaine anesthetizing solution; then, with the needle in place, changing the syringe for one containing the oil. This method is not favored except as a necessary

FIG. 17. Case S.D. Bronchogram with the patient in the oblique position to show the ramifications of the bronchiectasis.

substitute and we have used it only in young children. In the cases of two children we have used general nitrous oxide-oxygen anesthesia. The strain was less for the patients and the operation easier. Very satisfactory bronchograms were obtained while the patients were still anesthetized. There is much to recommend this method when good bronchograms are needed and the quiet cooperation of the patient cannot be expected.

Bronchoscopic Route. This is recommended by some because one can inject the lipiodol into a chosen single bronchus. However, we have not found it satisfactory because the lipiodol usually flows to other parts as the bronchoscope is withdrawn or is blasted about the bronchial tree by the heaving and coughing that almost inevitably attends and follows bronchoscopy. Furthermore, when lipiodol is injected into a single bronchus through a long cannula it seems easy to produce a roentgenographic artefact. The oil may accumulate in a pool, which is easily mistaken in the roentgenogram for a bronchial sacculation, and remains indefinitely encysted, perhaps to the detriment of the patient. We have seen a number of cases in which this occurred.

Injection of Fistulas, Sinuses and Abscess Spaces. This is a simple procedure and may be done with a needle or small catheter. It is well to wash out the tract before injecting the lipiodol, which is then allowed to flow in by gravity or under very low pressure; forceful injection may produce artefacts, trauma, or embolism (air or oil). Until the roentgenogram is made the lipiodol should be sealed, if necessary, in the tract by closing the external opening with adhesive plaster. Transparietal injection of pulmonary cavities is, in our experience, very seldom indicated.

SUMMARY

1. In order to secure the greatest diagnostic information from iodized oil bronchography and, at the same time, avoid the attendant hazards, an understanding of the behavior of oil in the lungs is fundamental. This is explained.

2. In most cases retained lipiodol is gradually discharged through the bronchi. Direct absorption through the lung occurs only to a slight degree, if at all.

3. A slight exudative reaction usually occurs about deposits of lipiodol in the healthy lung but this seems not to be harmful in the clinical sense. The transudation of edema fluid may be considerable and this may account for the rapidly developing roentgenographic lobar opacity reported by some authors.

4. Lipiodol may be retained for days, months or years in the pulmonary alveoli. From the roentgenological point of view, this "contrast medium infiltrate" is a diagnostic disadvantage. The persisting densities may impair the value of serial roentgenograms as guides for treatment.

5. Disadvantages and dangers peculiar to the cricothyroid or transtracheal method of injection include the escape of oil into and indefinite retention in the cervical and mediastinal tissues; the more or less serious infection of these tissues by escaping bronchial discharges; and, less often, pain, dys-

phonia, edema of glottis, dysphagia, subcutaneous emphysema and air embolism.

6. Iodism is due mostly to the swallowing of the oil and absorption of iodine through the intestine. Usually it can be avoided by carefully injecting the oil in small amounts, adopting measures to prevent retention in the lungs, postural drainage of the bronchi after bronchography, and finally the administration of a brisk saline purge.

7. In cases of infectious pulmonary disease, mainly tuberculosis and acute or chronic suppurative conditions, dissemination or aggravation can be caused by lipiodol injection. The reasons for this are given. Serious results and several fatalities are placed on record.

8. Cases are also cited to prove the potential—even fatal—risk of intratracheal injection of iodized oil in cases with impaired cardiac or respiratory function from different causes.

9. Rational and effective ways to avoid the disadvantages and hazards are described. By adopting these measures the many advantages of lipiodol bronchography can be achieved usually without harm to the patient.

10. Principles governing the selection of cases are stated. The technique of safe, adequate and simple methods of performing the procedure are described.

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TUBERCULOSIS OF THE KNEE JOINT

A COMPARISON OF ITS MORBID ANATOMY WITH ITS ROENTGENOLOGIC MANIFESTATIONS

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IT CAN be readily understood that correct interpretation of roentgenograms of diseased joints is by no means easy when it is considered how seldom they are checked by pathologic data. Simple exploration of a joint may lead to a fairly accurate conception of its contents, but many details of such explorations necessarily are not recorded. This lack of accurate corroboration of roentgenologic data has, in many instances, led to incorrect interpretation. Opportunity has been given us to study a series of specimens of resected knee joints and to compare the pathologic changes thus found with the clinical records and roentgenograms. The results of our observations are presented.

MATERIAL STUDIED

A series of 113 resected knees and seven amputated legs was studied. Ninety-five (84.1 per cent) of the resected knees were diagnosed as tuberculous by pathologic examination, 17 (15 per cent) were found to be inflammatory and one (0.9 per cent) presented the typical picture of a Charcot joint. All the amputated legs were tuberculous; an incidence of tuberculosis in the series of 85 per cent.

In the entire series there were 77 cases in which roentgenograms of the knee were available. Of these, 65 cases were tuberculous, 11 were nontuberculous arthritis, and one case was a Charcot joint. In each case a complete gross specimen of the knee joint had been preserved from which microscopic sections were cut in order to corroborate the original pathologic diagnosis.

PATHOLOGIC CHANGES

By the time a patient suffering from a tuberculous knee joint has sufficient trouble to consult a physician, or, more often, by the time trouble has become sufficiently established so that the physician can recognize or even suspect tuberculosis, the pathologic changes have usually become so far advanced as to involve both synovial membrane and bone. The older conception of primary disease of the bone or primary disease of the synovia was the basis for many futile arguments. It is our belief that, with few exceptions, we do not recognize the disease clinically until it has invaded both structures.

In any case the disease is a hematogenous infection secondary to tuberculosis elsewhere in the body, although the focus is not often apparent. Beginning with the miliary tubercle, usually in the epiphysis, the infection in the bone may become walled off and temporarily inactive; it may spread toward the joint, attacking and perforating the cartilage, or it may advance to the synovial membrane at its point of reflexion from the bone. The structure of the bone may be gradually replaced by tuberculous granulation tissue, whereas areas of bone may become necrotic, with formation of sequestrum due to interference with the blood supply, or areas of caseation may occur with the formation of abscesses of bone which may later perforate the joint. The synovial infection whether primary or secondary to a lesion of bone is characterized by the formation of a marginal tuberculous pannus which creeps over

the articular surface, eroding the cartilage as it goes. At the central pressure area this is usually rubbed off by the opposing articular surface, so that this portion of the cartilage tends to be preserved longer. At the same time there is marginal infiltration and destruction of the bone and the production of subchondral granulation tissue, which spreads toward the center of the joint, eroding the cartilage from below. This tissue may or may not have the characteristics of tuberculosis. In some cases it dips down at the pressure area to separate a sequestrum from the surrounding bone, and often it lowers the resistance of the central cartilage so that it is destroyed by pressure erosion from above. Therefore, although in some cases the greatest cartilaginous destruction is peripheral, in others it is at the area of greatest pressure. In practically all cases there is atrophy of bone due to tuberculous infiltration and disease. Cartilage is destroyed very slowly and may be preserved in the joint for years, although devitalized and separated from the bone. It is replaced slowly by fibrous tissue, so that ankylosis of bone does not occur in these cases unless secondary infection is present. As a basis for comparison we shall refer frequently to the 11 nontuberculous specimens on which we have complete data, including the roentgenograms.

HISTORICAL DATA

König, in 1884, presented the first clear-cut description of the disease, as noted in a large series of pathologic specimens, and very few additions of note have been made to his work. In 1906, he mentioned the roentgen rays as a factor in diagnosis, pointing out the uniform atrophy of bone, the destruction of cartilage, the presence of abscesses in bone and sequestra, and the slow progress of the disease, as demonstrated by the roentgenogram. He noted, however, the inability to visualize the early wedge-shaped tuberculous areas in surrounding healthy bone, or the tuberculous granulation tissue whether in the bone or in the joint, and intimated that tuberculosis might be present for some time before roentgenologic changes became apparent.

Since König's pioneer work, opinions have differed as to the diagnostic value of the roentgenogram. Fraser described the encysted, infiltrating, atrophic and hypertrophic pathologic varieties of the disease in bone and was able to identify each on the roentgenogram. He pointed out the smoky, bulging synovia, marginal surface and deep erosion of cartilage of the joints and finally destruction of bone. Ely stated that the roentgenogram should only be used as confirmatory evidence, and although a well-defined focus in bone can be distinguished, roentgenograms of synovial tuberculosis are often of little value. Woldenberg confessed his difficulty in distinguishing tuberculosis from other types of arthritis by means of roentgenograms. One of us (Ghormley) in a previous article pointed out the marked infrequency of roentgenologic changes in early cases of tuberculosis of joints. Most recent writers have concurred in this view, among whom are Sundt, Girdlestone, and Allison. Allison claims that syphilis or gonorrhea may produce identical capsular and cartilaginous changes, that formation of new bone is not infrequently seen in tuberculosis and that thinning of the cortex is seen in all bones that are not used. The last mentioned factor has been stressed by Phemister[9] who stated that interruption or loss of cortical substance on the articular surface is the most definite roentgen sign in tuberculosis, occurring from four to twelve months after the onset of the disease. He also attached great significance to the preservation of cartilage and hence the width of the joint space at the areas of greatest pressure, notably the central areas, and the external surfaces rather than the internal. He noted the presence of marginal erosion, due to invasion of bone by tuberculosis beneath the cartilage at the point of synovial reflexion, but also observed articular lipping in some cases.

Briefly, the usual roentgenographic characteristics of tuberculous arthritis as described by various writers are: (1) atrophy of bone; (2) general haziness of the joint; (3) erosion of margin of bone; (4) thinning or interruption of the articular cortex; (5) abscesses of bone or sequestra in some cases, and (6) late preservation of the cartilage of the joint and normal width of the joint space. The latter is explained by Phemister[10] by the absence of proteolytic ferments in the tuberculous exudate, permitting the presence of the cartilage even though dead and separated from the bone, the process of digestion, absorption and narrowing of the joint space being thereby prolonged.

On the other hand, the following signs are thought to occur in cases of the monarticular form of nontuberculous infectious arthritis or in septic joints: (1) early and complete destruction of cartilage with narrowing of the joint space; (2) involvement of more than the margins of the areas of pressure; (3) the absence of abscesses of bone or sequestra; (4) a tendency to generalized or spotted hypertrophy; (5) articular lipping, and (6) ankylosis in the late stages of both the tuberculous and the nontuberculous varieties, together with advanced destruction of the articular surfaces of bone. In any case in which there has been disuse of the part for any length of time the ordinary changes will be modified by the usual atrophy of disuse.

FIG. 1. Tuberculous knee joint of two years' duration; destruction of external condyle and erosion of the margin of bone of both tuberosities may be noted.

ROENTGENOLOGIC DATA

In most of our tuberculous cases, well-marked atrophy of bone was discovered on roentgenologic examination. The exceptions were, however, numerous. In the 65 cases of tuberculosis, atrophy of bone was present in 50 (76.9 per cent); increased density of bone or hypertrophic changes in 8 (12.3 per cent), and there was no appreciable change from the normal in 7 (10.8 per cent). In 3 cases the hypertrophic changes were so pronounced as to suggest a preoperative roentgenologic diagnosis of Charcot joint. In the series of nontuberculous cases atrophy of bone was noted in 7 (63.6 per cent); hypertrophic changes were noted in 2 (18.2 per cent), and the changes were negligible in 2 cases. It would seem, then, that atrophy could not always be used in these cases as a differential diagnostic point.

DESTRUCTION OF CARTILAGE

Since cartilage is practically completely permeable to the roentgen ray, the only standard by which to judge its destruction or preservation is the amount of narrowing seen in the joint space. This interpretation must be made with care, because other fac-

FIG. 2. The thick adherent pannus covers the external condyle of the gross specimen. The exposed cartilage shows only moderate destruction. Specimen from same case as that shown in Figure 1.

tors may cause modification of the roentgenographic appearance of the intra-articular area. The most important of these factors is the position of the knee at the time the roentgenogram is made. The greater the flexion at the knee, the narrower will be the representation of the joint space on the film, regardless of the amount of cartilage remaining. Ligamentous relaxation, displacement of the semilunar cartilage or subluxation of the joint will necessarily modify the width of the joint space in the roentgenogram. Stereoroentgenography is helpful in determining the actual width.

In 49 (75.4 per cent) of the tuberculous cases varying degrees of cartilaginous destruction were present; localized destruction over the external surfaces was present in 7 (10.8 per cent), involvement only of the patellar cartilage in 3 (4.6 per cent), no definite change was noted in 4 (6.2 per cent) and flexion of the knee prevented comparable interpretation in 2 (3 per cent).

Comparing these observations with the actual condition existing in the gross specimens, the roentgenologic interpretation proved to be correct as to the amount of cartilaginous destruction in 55 cases (84.6 per cent). In 2 cases (3 per cent) the roentgenograms suggested more destruction than was actually apparent, and in 6 cases (9 per cent) we had underestimated the amount of cartilaginous disease.

In the 11 nontuberculous cases the amount of destruction of cartilage seen in the roentgenograms checked with the gross changes in 6 cases (54.5 per cent) and less degeneration was shown in 5 (45.5 per cent) than actually existed.

On comparing the roentgenograms of the tuberculous and nontuberculous cases, we found that as a rule in the latter group

FIG. 3. The soft tissues of the same specimen as Figure 1 have been removed by caustic, demonstrating the actual destruction of bone.

there was more rapid and extensive narrowing of the joint space for a given duration of disease. Certain definite exceptions to the rule, however, were noted, so that this form of differentiation may be suggestive but by no means conclusive.

DESTRUCTION OF BONE

Fifty-six (86.1 per cent) of the roentgenograms in the tuberculous cases disclosed definite destruction of bone. Among these, there was involvement of all the articular surfaces in 31 cases, only the external surfaces in 8, the internal in 4, the tibia alone in 7, the femur in 4 and the patella in 2. In 39 cases (60 per cent) the roentgenologic data agreed with the changes seen in the gross specimen, and in 26 (40 per cent) there was apparently more destruction than that from inspection of the specimen. The reason for this discrepancy is the marginal and subchondral erosion of bone which may occur without destruction of cartilage, and the fact that often a pronounced surface pannus will cover the area of destruction. Thus, at the time of operation, or when the specimen is casually observed, there seems to be no lesion present, since the surface of the bone appears intact. In some cases destruction can be noted in the cut surfaces of the bone. On cutting through the articular surfaces or denuding the bone by means of caustic, these changes become apparent (Figs. 1, 2 and 3). On the other hand, what appeared to be marked destruction of bone in the roentgenograms frequently represented little change in the gross specimen. In about half the nontuberculous cases the roentgenograms were similarly more informative than the macroscopic appearance of the gross specimens. In 9 (81.8 per cent) of the 11 cases destruction of bone was seen on the roentgenogram. But here again there is no definite distinguishing feature between the two types of arthritis.

AREA OF GREATEST DESTRUCTION

It has been stated that in tuberculous cases the greatest destruction in joints is marginal, whereas in nontuberculous cases it is central. In 29 (44.5 per cent) of the tuberculous cases, there was greater destruction of bone at the pressure areas, in 14 (21.5 per cent) greater marginal destruction, and in 22 (34 per cent) no difference was noted. These observations corresponded in the gross specimens in 49 (70.7 per cent) of the cases.

In 8 (72.7 per cent) of the nontuberculous cases there was greater destruction at the pressure areas, in one case (9.1 per cent) the marginal destruction was greater and in 2 cases (18.2 per cent) the destruction was generalized. These observations agreed with the gross observations in 5 (45.4 per cent) of the cases. With the microscopic sections as additional evidence, we found it impossible to make any uncompromising rule concerning the area of greatest destruction as a differentiating feature.

Fig. 4. Nontuberculous knee joint with diminution of the joint space and marginal erosion of the bone. Condition of two years' duration.

FIG. 5. Tuberculosis of the knee joint of three years' duration; marginal erosion of the posterior aspect of the external condyle on the lateral roentgenogram may be noted.

MARGINAL EROSION AND LIPPING

In 32 (50 per cent) of the tuberculous cases definite erosion was present at the margins of joints. In 3 cases (4.6 per cent) there was marginal lipping, whereas in 3 (4.6 per cent) both erosion and lipping were noted. In one case (9.1 per cent) of the nontuberculous cases there was definite erosion of the margin (Fig. 4), and in 3 (27.3 per cent) there was marginal lipping. There seemed to be undoubtedly a preponderance of erosion in the tuberculous cases and lipping in the nontuberculous cases. The marginal destruction noted grossly and microscopically in the tuberculous specimens is ordinarily so much greater than that seen in the nontuberculous cases as to explain these roentgenologic findings.

CORTICAL INTERRUPTION

Interference with the continuity of the articular cortex due to the inflammatory changes was present in 62 (95.3 per cent) of the tuberculous cases and in 9 (81.8 per cent) of the nontuberculous cases. In 2 of the tuberculous cases without cortical interruption the inflammation occurred very early (eight and eleven months) but microscopically invasion of bone was definite. The third case was of two years' duration, but infiltration of bone was slight and limited to the margin, although the cartilage was destroyed and replaced by fibrous pannus. However, in the cases with cortical interruption, 3 were early (six, seven and ten months' duration). Of the 5 cases of less than one year's duration marginal erosion was present in one (2 per cent), whereas in 3 (6 per cent) interruption of the cortex was present. Therefore, this sign may, as Phemister stated, be the first to be observed in the roentgenogram. It is nevertheless true that by the time it appears,

FIG. 6. The eroded area on the gross specimen (same case as Figure 5).

definite tuberculous changes have occurred, so that it cannot be termed an early diagnostic sign.

SYNOVIAL THICKENING

A general haziness of the structures of the joints was noted in a small percentage of our tuberculous cases. Synovial thickening was present in 20 (30.8 per cent) of the tuberculous cases and in 4 (36.3 per cent) of the nontuberculous. In the 5 early cases of tuberculosis the synovia was thickened in 3 (60 per cent). Judging from the gross and microscopic specimens all were thought to be of synovial origin. One of the 2 cases without synovial thickening was definitely of synovial origin, but in the other 3 there was a question of a primary focus in the bone. In other words, of 4 early cases thought to be synovial in origin, marked synovial thickening was seen in the roentgenogram of 3 (75 per cent). Therefore, it would seem that in the early cases of primary synovial origin this sign is more valuable than interruption of the cortex of the bone. Diagnosis by the roentgen ray alone of synovial thickening due to tuberculosis may, however, offer many difficulties. It can no doubt at times be recognized, but in the absence of other distinguishing signs, the thickening is hard to distinguish from the nontuberculous form. If secondary to a focus in the bone, the synovial thickening is of no importance as an early sign, although it may be the first roentgenologic evidence of cryptic disease of bone perforating the joint. In the cases in which slight changes appeared in the roentgenograms, definite involvement of both synovia and bone was always visible in the gross and microscopic specimens, and there was no characteristic roentgenologic feature to distinguish them from the cases of nontuberculous arthritis.

ABSCESSES OF BONE

Definite localized abscesses appeared in the roentgenograms in 5 (7.7 per cent) of our tuberculous cases and in none of the nontuberculous cases. We considered as abscesses rarefied circumscribed lesions either entirely surrounded by bone or on the articular surface extending into the joint at some point other than the margin. Such localized rarefactions when found at a point of synovial reflexion were thought to represent walled off areas of destruction of bone secondary to contiguous synovial disease. These impressions were corroborated by examination of the pathologic specimens (Figs. 5 and 6).

Fig. 7. Tuberculous knee joint, in which a large dense sequestrum in the internal condyle and smaller "kissing sequestra" in the external surface may be seen.

SEQUESTRA

The presence of localized hypertrophic changes in the ends of the bones, often

wedge shaped with the base on the articular surface, was noted in 12 (18.5 per cent) of our tuberculous cases and in one case (9.1 per cent) of the nontuberculous cases. All sequestra occurred in the areas of contact and pressure. Tuberculous sequestra were present in the tibia alone in 4 cases (6.1 per cent), in the femur alone in 3 cases (4.5 per cent) and in both bones in 5 cases (7.7 per cent). Opposing areas of eburnation in the tibia and femur, the so-called "kissing sequestra," were observed in 4 tuberculous cases (6.1 per cent), 2 being on the internal and 2 on the external surface (Fig. 7).

To test the accuracy of the roentgenogram in interpreting the presence of sequestra, we studied especially the films of cases and the gross specimens which definitely showed bony sequestra. Twenty of these were available. In 7 cases (35 per cent) the roentgenograms demonstrated the lesions present, and in 13 cases (65 per cent) they failed to show the exact condition although in some cases with more than one sequestrum the error was only partial. In one additional case a sequestrum noted on the film was not visible in the gross specimen, but was seen in the microscopic section through the joint surface.

Phemister[10] stated that the reason for the density of sequestra is that necrotic bone does not take part in the atrophy of the surrounding bone and hence appears more opaque in the roentgenogram. He pointed out that in the early stages of formation of sequestra this change will not be so apparent, and that if the sequestrum is formed after a large amount of atrophy has taken place, there will be little if any difference in the density of the dead and living bone as seen on the films. This may account for the failure of the roentgenograms to demonstrate sequestra which showed such a marked increase in density over the surrounding bone or even over normal bone. It seems more logical to account for this on the hypothesis of Leriche and Policard, who stated their belief that, whenever there is decreased blood supply to bone with consequent loss of nutrition, there follows an increased deposition of calcium in the part and a thickening of the trabeculae. When the blood supply is entirely cut off, the sclerosed bone dies and is separated from the surrounding tissue.

COMMENT

The roentgenologic diagnosis of tuberculosis of the knee from arthritis of a nontuberculous type remains a difficult problem despite recent advances in technique and interpretation. In the very early cases, roentgenographic signs are entirely lacking. For a given time there is probably more to be seen on the films in the nontuberculous type than in the tuberculous. In the cases of short duration, pure synovial tuberculosis will be represented by synovial thickening and sometimes haziness of the joint. The nontuberculous cases, however, will in almost similar proportion show thickening of the synovia, although the general haziness occurs less frequently. Marginal erosion is more suggestive of tuberculous involvement, but this change also is seen in the nontuberculous type. Marginal lipping, while present most often in the nontuberculous variety, does not exclude the diagnosis of tuberculosis.

Thinning and interruption of the cortex of bone occurs in both types of disease. While preservation of the joint space over a long period is more likely in cases of tuberculosis, its presence is often noted in the nontuberculous cases. The area of greatest destruction, both in cartilage and bone, may be either central or marginal in tuberculosis. In the nontuberculous cases it is practically always central. Atrophy of bone is seen in both varieties in a large proportion of cases, and roentgenograms of tuberculous joints may show sufficient destruction and hypertrophy to simulate the picture of a Charcot joint.

In the late cases of both types destruction is advanced and often distinction is impossible. Abscesses of bone and sequestra are definite indications of tuberculosis, but in a large percentage of cases sequestra

are not visible on the roentgenogram. In the questionable early cases, when laboratory data are essential for the determination of the type of disease, the roentgenogram offers little impetus toward the swing of the pendulum to one side or the other. In moderately advanced cases of disease it may offer a more accurate aid to diagnosis.

SUMMARY

A comparison is made between the roentgenogram and the gross and microscopic pathologic specimens in 65 cases of tuberculosis and 11 cases of nontuberculous arthritis of the knee joint.

In a large percentage of cases the roentgenograms accurately demonstrate the existing pathologic lesions, but, because of the similarity of the two processes, cannot be considered in most cases as dependable diagnostic evidence.

The principal shortcoming of the roentgenogram is the failure to demonstrate the early pathologic changes in bone or synovia and the presence of areas of sequestration.

The principal advantage of the roentgenogram is the demonstration of lesions of the bone which may remain hidden beneath more superficial disease of the synovia or even beneath structures that appear to be perfectly normal.

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CONGENITAL ABSENCE OF THE SUPERIOR ORBITAL WALL ASSOCIATED WITH PULSATING EXOPHTHALMOS*

REPORT OF FOUR CASES

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THE recognition of congenital absence of the superior and posterior orbital walls is of extreme importance in roentgen diagnosis.

In the first case which I observed in 1926 a previous erroneous diagnosis of sarcoma of the orbit with destruction of the orbital bony structures had been made, and the advisability of enucleation of the eyeball had been discussed (Fig. 1). In a somewhat similar case reported by Rockliffe and Parsons[3] actual removal of the orbital contents preceded by ligature of the carotid artery was performed and was followed by the death of the patient. In this case the whole of the bone of the orbit except for the floor and outer wall had never developed. Moore of London reports 4 cases[2] in all of which there was an associated diffuse neurofibromatosis or Recklinghausen's disease and pulsating exophthalmos. In at least 2 of the 4 cases here reported there was evidence of neurofibromatosis, and all 4 cases had pulsating exophthalmos. One of the cases in addition had localized gigantism of the right leg due to a congenital arteriovenous fistula as described by Horton.[1] This case also had a congenital deformity of the cervical vertebrae.

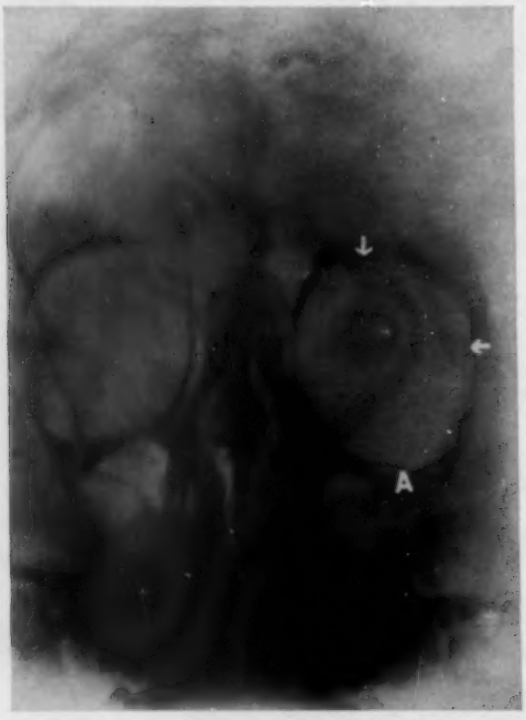

FIG. 1. Case 1. Congenital absence of the superior orbital wall, left side. Note the absence of bone detail on the left side, and the dropping of the orbital floor, A, and diminished size of the maxillary sinus.

CASE 1. Female, aged fifteen, was referred to me on September 20, 1926, by Dr. Arthur A. Boyer, with a question of erosion of the left orbit, about which there had been a difference of opinion, some having considered the lesion as sarcoma of the orbit (Fig. 2). This case gave a history of poor sight and nystagmus since birth, *left* eye. Pulsating tumor of left orbit increasing very slightly since birth had been noted. Was a seven months baby delivered without instruments. On May 12, 1923, Dr. Wurdeman, Seattle, Washington, made an examination and reported sight of right eye 6/15, left eye 6/60. Head dolichocephalic. No pain. Internal strabismus, left eye, and slight ptosis. The father, an army officer, was transferred to New Jersey for recruiting duty and the patient was to enter a school in Orange. The excitement brought on a temporary increase in the exophthalmos and the pulsation. She had also been seen by Dr. Arnold

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Knapp and Dr. Weeks. Dr. John Wheeler saw the case with me in consultation and agreed with the diagnosis of congenital absence of the superior orbital wall, associated with pulsating exophthalmos.

This case was successfully operated on by Dr. Walter E. Dandy of Baltimore on July 15, 1927 (Fig. 3). The following extracts are made from his report of the case.

"Aside from the local condition and related functions, a minor congenital deformation of the ear and marked thinning of the skull in the frontal region (lateral view), the physical and neurologic examinations revealed nothing of unusual interest. Her general condition was excellent.

"On looking at the eye from a lateral position, a pulsation, synchronous with the pulse, was easily seen. It was also palpable, but there was no thrill. No murmur was audible. Roentgenograms of the skull taken laterally and anteroposteriorly (both stereoscopic) showed that the posterior half of the roof of the orbit was missing. There was a small shelf internally and externally.

"A transplant of bone from the outer table of the skull was bridged across the roof of the orbit (Fig. 4). The curvature of this bone was essentially the same as the arch of the orbital roof. Moreover, the external and internal margins of the orbit were adequate to give a base on which the graft could rest and to which it should ultimately unite. A bed was chiseled from the external rim of the orbital roof where it joins the side of the skull, and into this notch the outer margin of the transplant fitted accurately and firmly. The graft was passed through a tunnel between the dura and the orbital contents. The inner margin of the transplant rested on the inner rim of the orbital plate, from which the dura and periosteum had been scraped to permit the transplant to lie in apposition with bare bone. The ends of the graft fitted so accurately that it was not necessary to wire the graft in place. The new superior orbital fissure was probably a little wider than normal but the difference was not great.

"Other details of the operation and abnormal observations: The outer surface of the brain was covered with large pools of fluid in the subarachnoid space; the leptomeninges were opaque and greatly thickened. The release of this fluid yielded adequate room to permit elevation of the brain without producing trauma. It was not necessary to puncture the lateral ventricle or to withdraw spinal fluid by lumbar puncture, as is the custom when intracranial room is at a premium. On retraction of the frontal lobe the defect in the posterior two-thirds of the orbital roof showed precisely as in the roentgeno-

Fig. 3. Case 1. Three years after bone transplant from temporal region of skull. Exophthalmos and pulsation cured. (Operation by Dr. W. E. Dandy.)

Fig. 2. Case 1. Note protrusion and slightly lower position of the inferior margin, left eye. Clinical diagnosis: pulsating exophthalmos. A previous erroneous diagnosis of "sarcoma" had been made.

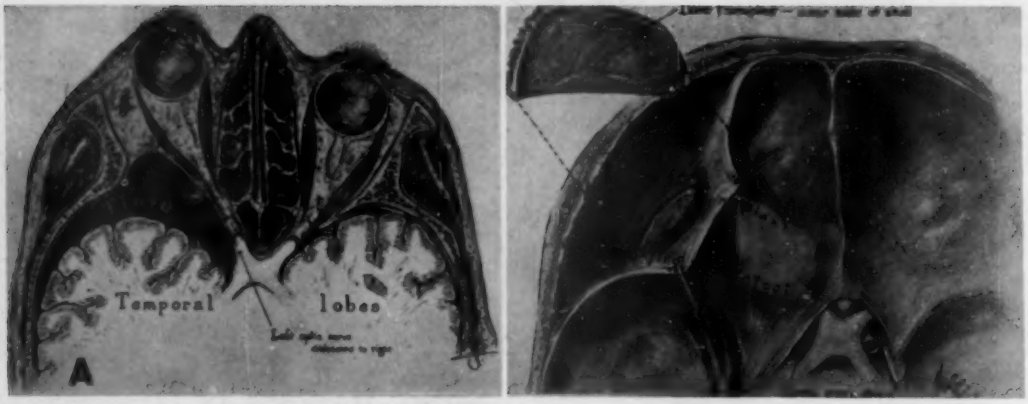

Fig. 4. Case 1. A. Dr. Dandy's sketch showing operative observations. The bed of fluid represents the meningocele which is pushing the orbital contents forward, downward and inward. B. Drawing to show the implantation of the bone through a subdural tunnel. The bone rested internally and externally on solid bone.

Fig. 5. Case II. Congenital absence of the superior orbital wall, left side. Localized gigantism of right leg associated with exostoses and increased length between knee and foot. This condition may be due to congenital arteriovenous fistula (Horton).

gram. The bony defect was everywhere covered by dura which was firmly attached to the eyeball. The dura extended backward with a gradual decline to and across the floor of the middle fossa. An isolated small fragment of bone lay between the dura and the eyeball.

"The tip of the temporal lobe was covered by tremendously dilated subarachnoid spaces, with opaque membranes—changes not unlike those on the surface of the brain, except in degree. Superficial examination might well give the impression that the tip of the temporal lobe, which was entirely hidden from view, was covered by an actual cyst. These large subarachnoid spaces were continuous through the sylvian fossa with similar spaces over the frontal and parietal lobes. The maximum depth of fluid was about 2.5 cm. The intact temporal lobe lay beneath the bed of fluid.

"Three small veins crossed from the external surface of the temporal lobe to the orbital tissue piercing the dura en route. They were doubly ligated with silver clips and divided. With these veins out of the way and the bed of fluid evacuated, the view of the entire anterior and middle fossa was unobstructed. A tremendous anomalous vein lay along the inner side of the middle fossa and outside the dura. It was formed by the confluence of two large veins—doubtless the superior and the inferior orbital veins—which also pierced the dura covering the orbital contents. It doubtless represented an extradural cavernous sinus. Posteriorly, the ultimate destination of the vein could not be traced.

"The left optic nerve was bent to the right, due to the pressure of the large cup of fluid on the tip of the temporal lobe. Search was made for the carotid artery which always stands out conspicuously alongside the optic nerve, but it could not be found. It is interesting that both the internal carotid artery and the cavernous sinus were absent. Knowing that the carotid artery in its transit through the skull passes through the cavernous sinus, I was led to wonder if the absence of the cavernous sinus might not lead to the loss of the internal carotid artery. No attempt was made to disclose the other nerves entering the orbit. The anterior clinoid process on the left side was absent."

Final Results. A slight downward displacement of the eyeball still remained. There was no exophthalmos or pulsation of the eyeball. The eyes focused well. The extra-ocular movements were nearly perfect five months later. There was no diplopia.

The report of Dr. Woods' examination was as follows: "Exophthalmometer readings: Right 19 mm., left 24 mm. The best vision on the right is 20/30; on the left 20/100. There is a slight concentric contraction of the left visual fields though the change is not great. In addition to the exophthalmos, the left eye deviates downward and inward. A fine vertical nystagmus is present. The optic disc is normal in outline; the physiological cup is a little blurred; the disc is flat with slight overfilling and rather marked tortuosity of the veins. The pupils are equal and react normally to light and accommodation."

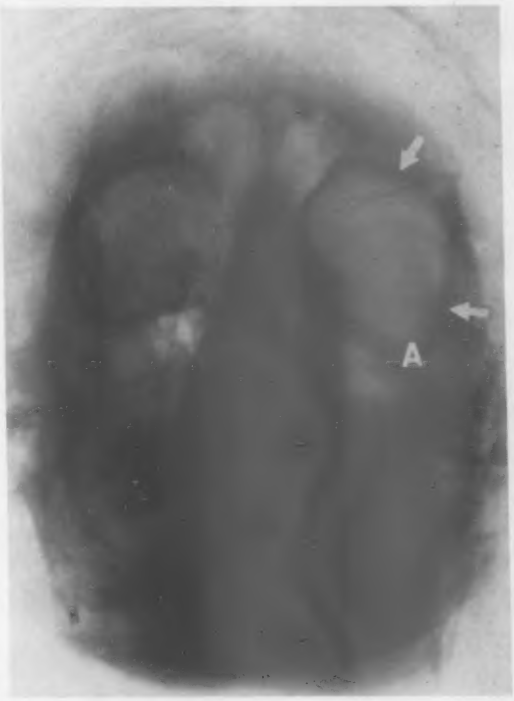

Fig. 6. Case II. Note the absence of bone detail on the left side, and the dropping of the orbital floor, A, and diminished size of the maxillary sinus.

Case II. Male, aged twenty-six, referred to me by Dr. W. W. Griffin, has been under my observation for the past twenty years (Fig. 5). A tumor mass was first noticed along the external surface of the right lower leg in about the mid-portion, without any pain, at about the age of ten years. At the age of fourteen he had his first roentgen examination at the Gibbs Laboratory, at which time his condition was diagnosed as localized gigantism involving the right leg. Another roentgen examination was made at St. Luke's Hospital at the age of twenty-one. On April 27, 1927, I again saw the patient, at which time he complained of pain in the right heel as though something had struck him. The pain started

Fig. 7. Case 11. A. Note the lower position of the eye. B. Neurofibromatosis. Similar lesion on the front of the body. Localized gigantism of the right leg. (See Figs. 5 and 6.) Clinical diagnosis: pulsating exophthalmos.

several days previous to his visit, at which time there was also noticed some swelling. The findings of localized gigantism involving the right leg were confirmed. The peculiar outgrowths on the inner side of the right tibia had increased, but still retained the appearances of a benign bone lesion. To an observer who had not had the advantage of the history of the case, malignancy would immediately be suspected, but the benign nature of the lesion is borne out by the duration of the observation of some twenty years or more. There is also hypertrophy of the soft parts of the leg, this condition not being limited to the region of the bony outgrowths. There is also some hypertrophy of the left fibula with irregularity of outline. The largest outgrowth in the region of the middle of the tibia measures approximately 13 cm. in length and 4 cm. in width. This outline is somewhat oval in shape and has fairly smooth borders. Below this there is an irregular outgrowth measuring about 11 cm. in length and varying from 1 to 3 cm. in width. The outline of the inner border of this projection shows fairly sharp angulations. However, there is a distinct limitation to the outgrowth and no tendency to the formation of new bone beyond the main growth. The density of the outgrowth is about half that of the shaft of the bone. It is somewhat irregular with the appearance of irregular trabeculations. The entire shaft of the tibia shows increase in density when compared with the opposite side. The entire left leg, including the bones, shows a length amounting in the case of the tibia to approximately 5 cm. greater than the opposite side. The shadow of the middle third of the right leg measures approximately 16 cm. as compared with approximately double that diameter on the opposite side.

It was noticed on physical examination that the left orbit was lower than the right and that there was some pulsation without exophthalmos. Roentgen examination revealed congenital absence of the posterior wall of the orbit on the left side (Fig. 6). This case

had previously been examined by an oculist who had apparently missed the deformity and the pulsation.

Examination of the skin showed multiple soft projecting tumors varying in size from a few millimeters in diameter to about 2 cm. in diameter. These are scattered over the front and back of the chest, the buttocks and thighs down to about the lower third (Fig. 7). The arms, forearms, hands and neck also show involvement. These areas would appear to indicate the presence of Recklinghausen's disease or multiple neurofibromata.

Roentgen examination disclosed a congenital deformity of the cervical vertebrae.

In view of recent studies by Dr. Bayard T. Horton of the Mayo Clinic, the gigantism of the lower extremity is regarded as being due to a congenital arteriovenous fistula.

Case III. Female, aged eighteen, was referred to me on December 12, 1931, by Dr. John M. Wheeler. This case had a pulsating exophthalmos of the right eye (Fig. 8). There was a tumor mass involving the right upper lid. Roentgen examination revealed an absence of the bony wall at the posterior border of the right orbit. This appearance is practically the same as that observed in two other patients. In addition to the deficiency in the posterior wall there is also deficiency in the superior and also in the external wall of the right orbit. This case also had an extensive pigmented birthmark extending over both buttocks and back and thighs.

Case IV. Female, aged nine, was referred to me on August 25, 1932, by Dr. John M. Wheeler. When the patient was 4½ years old she had infantile paralysis and the mother noticed that the entire right side of her face seemed to droop and the right eye protrude (Fig. 9). Pulsation of the eyeball was noted and the patient was then seen by Dr. Wheeler, who made a diagnosis of pulsating exophthalmos. After studying the other cases in which there was a congenital absence of the superior orbital wall a survey of the records

Fig. 8. Case III. A. Pulsating exophthalmos, right eye, associated with neurofibromatosis of lid and other regions of body. B. Note absence of the superior orbital wall, right side, associated with lower position of the inferior wall and smaller maxillary sinus than on the other side. (Courtesy of Dr. John M. Wheeler.)

Fig. 9. Case IV. Congenital absence of the superior orbital wall, right side. A. Note exophthalmos of the right eye. Clinical diagnosis: pulsating exophthalmos. B. Note the absence of the posterior superior orbital wall, right side, associated with lower position of the inferior wall and smaller maxillary sinus than on the other side. (Courtesy of Dr. John M. Wheeler.)

of cases previously diagnosed as pulsating exophthalmos resulted in having the patient return for roentgen examination which confirmed the fact that there was a congenital absence of the superior orbital wall. No other anomalies were noted in this case and no evidence of Recklinghausen's disease has yet manifested itself. There is definite deformity apparently of congenital nature involving the right orbital wall. There is evidence of deficiency in both the superior and lateral portions of the wall. The inferior portion is also partly deficient and is lower than the opposite side. This has resulted in a much smaller antrum on the right than on the left. Lateral exposure shows an apparent absence of the anterior clinoid processes. The diploic channels are very large. The convolutional markings are more prominent especially in the occipito-parietal region.

Fig. 10. Pulsating exophthalmos reported by Moore. No roentgenogram published, but case is apparently one of congenital absence of the superior orbital wall.

There are several cases reported in the literature in which pulsating exophthalmos was not definitely recognized as being due to a congenital defect in the superior orbital wall (Fig. 10). In some of the cases, however, roentgenograms are published showing this condition (Fig. '11). *Other cases are referred to in the literature in which*

the eye has been removed and no tumor found. Moore[2] reports as follows:

"Rockliffe and Parsons published a case in which the patient, a child of two, died after exenteration of the orbit preceded by ligature of the carotid artery (Trans. Path. Soc., 1903). In their case the whole of the bone of the orbit except the floor and outer wall had disappeared, or *I suspect had never developed*, so that the growth was in direct continuity with the cranial cavity, a fact which no doubt was responsible for the pulsation." (Italics mine.)

In another case the carotid artery was ligated in the belief that the orbital mass was of a vascular nature.

Schüller[4] reports a case as follows:

"H., male, twenty-eight years of age. Trauma of the head in early youth. Deformity of the skull and face from early childhood. At the time of examination there was an exophthalmus pulsans. It was possible to push the eye back. There was bulging of the right temporal region, and thickening of the tissues of the right side of the face, resembling elephantiasis.

Fig. 11. Roentgenogram of a case which Dr. M. J. Hubeny has been good enough to send me and which shows the absence of the superior and posterior orbital wall as indicated by the arrows.

Fig. 12. Schüller's case. Pulsating exophthalmos of right eye, associated with absence of upper and posterior portions of the orbital wall, assumed to be due to lymphangioma, but which, in my opinion, may be due to a congenital defect.

"*The roentgen examination permitted one to see that the upper and posterior portions of the orbit were gone.* The wall of the skull, corresponding to the right temporal region, appeared thinned, bulged outward, and rarefied by the presence of numerous vascular canals. The floor of the right middle cranial fossa was lower than the left. The sella turcica was shallow and widened at the top. Taking into consideration the change in the facial skin, a lymphangioma was assumed as the cause of the symptoms. It is probable that the circumscribed destructive changes in the orbital wall, the skull base, and the temporal region were produced by a portion of the lymphangiomatous tumor, lying intracranially." (Italics mine.) (Fig. 12.)

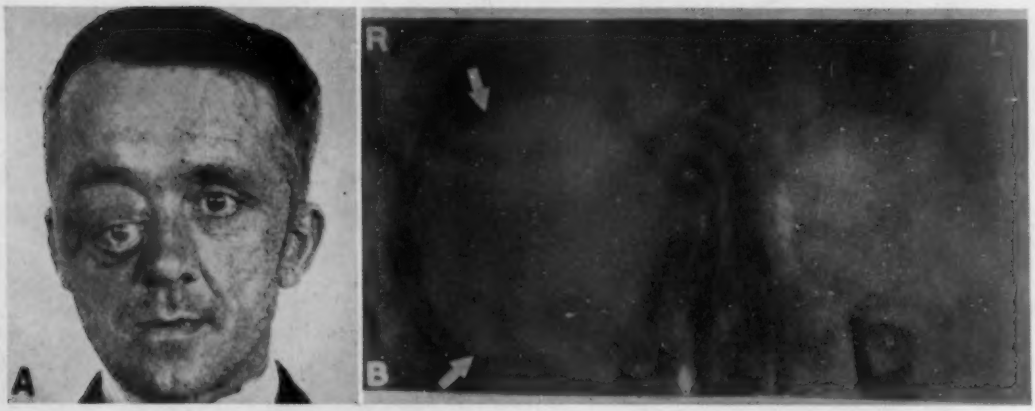

Fig. 13. Moore's case. A. Pulsating exophthalmos, right eye. Ligation of carotid artery, but pulsating and protrusion continued, neurofibromatosis also present. B. Roentgenogram shows deficiency of posterior orbital wall and larger orbital cavity on the right side. This case might easily have been mistaken for sarcoma.

Moore also reports a case in which ligation of the carotid artery was performed, but no definite aneurysm was found and the exophthalmos continued. This case was also associated with neurofibromatosis, similar to that observed in one of my cases (Case II) and also in one of the cases referred to me by Dr. Wheeler (Case III). (Fig. 13.)

SUMMARY

1. Congenital absence of the superior orbital wall causes pulsating exophthalmos. The condition is easily distinguished roentgenologically from sarcoma of the orbit, especially in view of the fact that there is usually deformity of the floor of the orbit in addition to the other bony changes. The inferior margin of the orbit may be lower than the corresponding region on the normal side.

2. Four cases of congenital absence of the superior orbital wall are reported. In one case the diagnosis has been confirmed and a new orbital wall constructed by a bone transplant from the skull. (Dandy.)

3. Two of the cases had associated lesions due to the presence of diffuse neurofibromatosis (Recklinghausen's disease).

4. One case, in addition to the associated Recklinghausen's disease, had a congenital arteriovenous fistula of the right leg, causing localized gigantism, and also had a congenital deformity of the cervical spine.

5. In the routine examination of roentgenograms of the head it is advisable for the roentgenologist to study carefully the bony outline of the orbits, in addition to a study of the nasal accessory sinuses.

6. Enucleation of the eye, or ligation of the carotid artery, should never be performed in a case of pulsating exophthalmos, unless a roentgen examination has been made and shows no evidence of congenital absence of the superior orbital wall.

Note: Just prior to publication, the importance of a roentgen examination and proper interpretation prior to the removal of an eye are made more imperative due to a recent court decision whereby the parents were ordered by the court to have the child's eye removed for a tumor. This decision was made about April 19, 1933, in the case of a two-year-old girl over the protests of her parents, by a judge in the children's court, and was sustained by the Appellate Division of the Supreme Court in Brooklyn, New York, five justices concurring in adjudging the baby to be a "neglected child" and in holding that the State has an affirmative control over the child's physical welfare under the 1922 children's court act. In this particular case the tumor was stated to be due to a glioma and the eye was removed fortunately before invasion of the optic nerve had occurred. But, had the case been one of pulsating exophthalmos and the eye needlessly sacrificed, both the medical and legal profession would have been subject to criticism.

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Vol. XXX, No. 6

PITUITARY ADENOMAS*†

By ROBERT C. MOEHLIG, M.D.
DETROIT, MICHIGAN

THE fact that roentgenologists are frequently called upon to treat endocrine disorders is justification for presenting certain phases of endocrine problems. Particularly in pituitary and ovarian disturbances, the aid of the roentgenologist is frequently sought for treatment. It is in this type, which frequently leads to amenorrhea in the female and impotency in the male, that the roentgenologist must be on his guard. Not infrequently the patient feels that the roentgen treatment caused the amenorrhea or impotency, not knowing of course that the condition for which she was treated was the real cause. The patient should be told before treatment is instituted that the endocrine disturbance for which she is being treated may lead to amenorrhea and sterility.

Quite recently I saw a case of a girl who had been working in the office of a roentgenologist for twelve years and had developed amenorrhea. Because of her association, she knew that the roentgen ray was used to produce this in certain conditions and was inclined to place the blame for her amenorrhea on the roentgen ray.

While the diagnosis rests upon the referring physician and is not the immediate concern of the roentgenologist, still no harm will be done in showing a few of the pituitary conditions which lead to changes in the sex glands.

The pituitary cells are classified according to their staining qualities as follows:

(A) The chromophobe or chief cells which take stains rather poorly.
(B) The eosinophil cells which have an affinity for the acid eosin.
(C) The basophil cells which have an affinity for the basic stain.

The chromophobe cells are believed by many to be the mother cell of all pituitary cells; they constitute about 52 per cent of all the cells. The eosinophils average around 37 per cent, whereas the basophils make up the balance of 11 per cent. These figures are naturally approximate and many variations of this number are found.

FIG. 1. Case 1. Chromophobe adenoma in a male showing inversion of sex characteristics.

When adenoma formation takes place in these cells, they give rise to a fairly characteristic syndrome. Each cell type produces a syndrome that can usually be recognized clinically.

The first type, the chromophobe adenoma (Fig. 1), makes its presence known by local pressure signs and a regression of physiological activity or, in other words,

* Of the three adenomas used to illustrate this article two (Cases I and III) have been published elsewhere (*Endocrinology*, 1929, *13*, 529–532; *J. Am. M. Ass.*, 1932, *99*, 1498–1500).

† Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Michigan, Sept. 27–30, 1932.

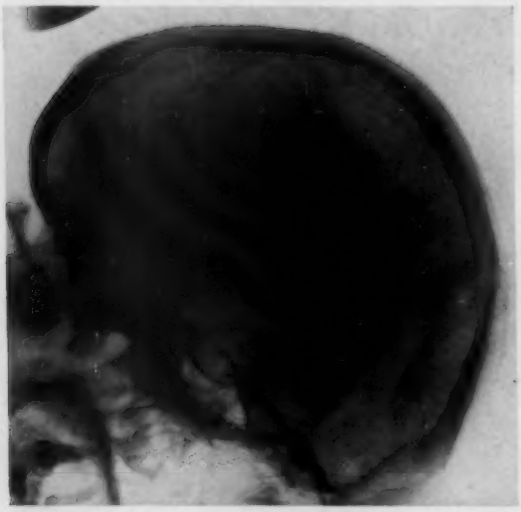

FIG. 2. Case 1. Roentgenogram showing very large sella turcica with erosion (chromophobe adenoma).

hypofunction. The tumors often reach a very large size before making their presence known. The roentgenogram usually shows a very large sella (Fig. 2). The chromophobe adenoma with hypofunction, or so-called dysfunction of the pituitary, may be compared to the colloid goiter with myxedema. In other words, the chromophobe seems to be the resting stage of the pituitary cell.

In the male, there is impotency with atrophy of the testicles and loss of secondary sex characteristics. Not infrequently they take on female characteristics so that they no longer shave due to lack of beard growth, the pubic hair assumes the triangular shape of the female and the skin is soft like that of the female. Gynecomastia may also be present (Fig. 1).

In the female, there is amenorrhea from lack of pituitary stimulation to the ovary and consequent failure of follicle ripening.

Some of the other findings in the chromophobe variety are: increased sugar tolerance; low blood pressure; secondary anemia; obesity and polyuria. These are in addition to the local pressure manifestations.

The second type, the eosinophil adenoma, gives rise to the well-known syndrome of acromegaly (Fig. 4). Here we have enlargement of the skeletal system and viscera. Kyphosis due to osteoporosis of the spine is usually present. A decreased sugar tolerance with glycosuria and hyperglycemia is found in a high percentage of cases. Masculinization of the female with hypertrichosis of face, arms and legs; male distribution of hair; deep bass voice and amenorrhea are usually present. Hypertension and atherosclerosis are a part of the picture. Polycythemia may also be present; connective tissue and fatty tumors are not infrequent.

Of interest is the fact that eosinophilism or acromegaly almost always occurs in the brunette and the individuals developing this disease take on the physical characteristics of the negro. The roentgenogram usually shows an enlargement of the sella turcia.

The third type of pituitary adenoma is the basophil adenoma, which results in the condition termed basophilism and which was recently described by Cushing[1] (Fig. 5).

[1] Cushing, Harvey. The basophil adenomas of the pituitary body and their clinical manifestations (pituitary basophilism). *Bull. Johns Hopkins Hosp.*, 1932, *50*, 137–195. Further notes on pituitary basophilism. *J. Am. M. Ass.*, 1932, *99*, 281–284.

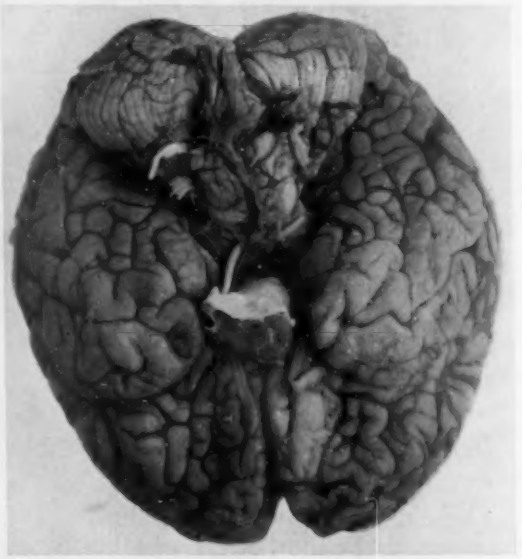

FIG. 3. Case 1. Under surface of the brain showing chromophobe adenoma.

This type is characterized by "a rapidly acquired, peculiarly disposed and usually painful adiposity, confined to the face, neck and trunk, the extremities being spared; a tendency to become round shouldered, even to the point of measurable loss of height, associated with lumbo-spinal pains; sexual dystrophy shown by early amenorrhea in the females and ultimate impotence in the males; an alteration of the normal hirsuties shown by a tendency to hypertrichosis of face and trunk in all females and possibly the reverse in adult males; a dusky plethoric appearance of the skin with purplish lineae atrophicae; vascular hypertension; a tendency to erythremia; variable backaches, abdominal pains, fatiguability and ultimate extreme weakness." Basophilism is usually seen in the brunette

Fig. 4. Case II. Eosinophil adenoma producing acromegaly.

Fig. 5. Case III. Case of basophil adenoma (Cushing's syndrome) which came to autopsy.

just as eosinophilism. The roentgenogram as a rule does not show any distortion of the sella turcica because the adenomas are so small.

We see, therefore, that all three types, the chromophobe, the eosinophil and the basophil adenomas, lead to amenorrhea. In the chromophobe variety with resulting hypofunction, there is a lack of stimulus to the ovarian follicle with resulting amenorrhea.

SUMMARY

Three cases are shown representing the three types of pituitary adenomas, viz., chromophobe, eosinophil and basophil.

The chromophobe variety leads to hypofunction of the pituitary and may be compared to the colloid goiter with myxedema.

The eosinophil adenoma produces acromegaly and represents hyperpituitarism.

The basophil adenoma produces the syndrome known as basophilism or Cushing's syndrome. It also represents a type of hyperpituitarism.

All three types produce amenorrhea. The three types may be diagnosed from their respective clinical pictures.

"MILIARY" PULMONARY HEMORRHAGES ON NECROPSY ROENTGENOGRAMS OF CHILDREN*

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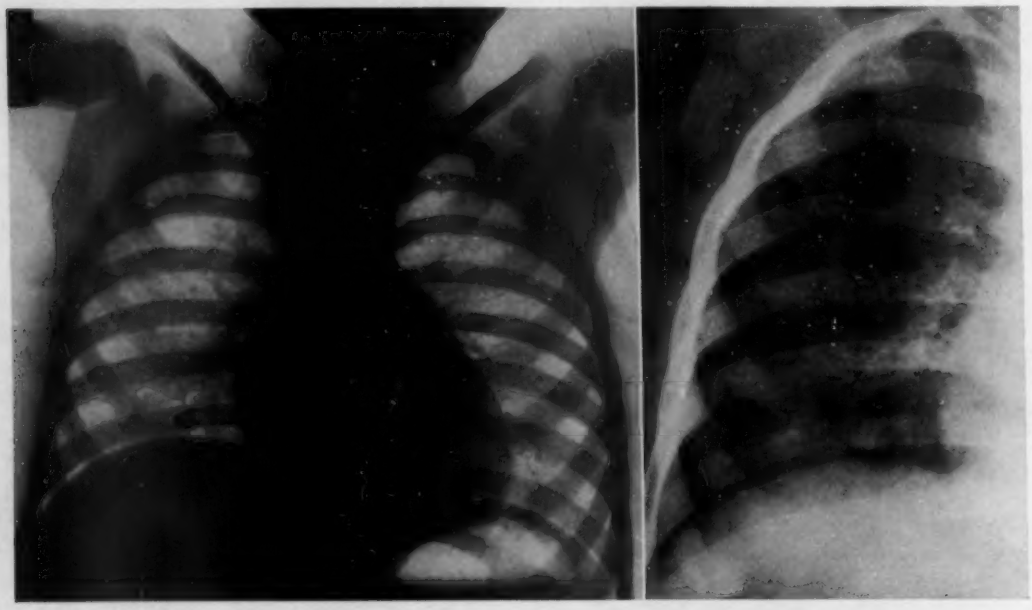
CHICAGO, ILLINOIS

WHERE post-mortem roentgenograms are used as an adjunct to necropsy or as a substitute for diagnostic purposes, when autopsy permission cannot be obtained, certain unusual appearances have been noted that have apparently not been recognized and seem worthy of reporting. I refer to the extensive capillary hemorrhages in the lungs which cast shadows on the roentgenogram so similar to that of other better known conditions that a mistaken interpretation would most likely occur. The films were made soon after death and just preceding necropsy.



(*a*) (*b*)

FIG. 1. Case 1. (*a*) Even distribution of fine shadows (isolated hemorrhages) throughout lung fields simulating roentgen appearance of early miliary tuberculosis. (*b*) Positive reproduction. Note fine mottled appearance caused by the hemorrhages.

CASE 1. White female, aged two and a half.

The history of this child was that of perfect health until she developed a diarrhea and fever four days before death. Several stools had contained blood and pus. On admission to the hospital the day preceding death, she was delirious, dehydrated, pale, and acutely ill, and had convulsions. Respirations were rapid. The temperature was 103.4° F. The white count was 15,200 with 58 per cent polymorphonuclears and 42 per cent lymphocytes. The red count was 3,900,000; hemoglobin 60 per cent. The chest examination was reported negative. The temperature rose steadily, reaching a terminal level of 107.5° F. The clinical diagnosis was acute bacillary dysentery.

The roentgenogram (Fig. 1) of the chest taken shortly after death showed fine soft densities scattered throughout both lung fields, which were interpreted as having the typical roentgen appearance of miliary tuberculosis.

Necropsy. The post-morten examination,

* This work has been made possible through post-mortem chest roentgen examinations established as a routine procedure by Dr. Joseph Brennemann at The Children's Memorial Hospital, Chicago.

which was limited to the trunk, showed no hemorrhages in the intestinal tract. The changes were those of a hyperemia and edema of the mucosa. Peyer's patches were prominent

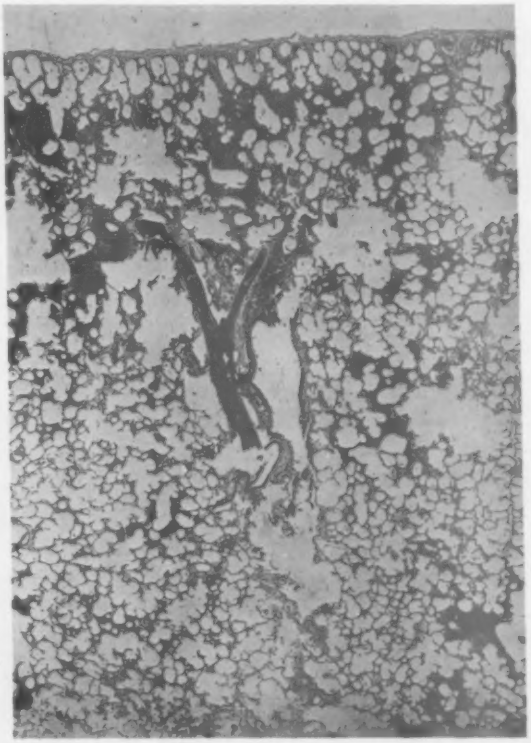


Fig. 2. Case 1. Photomicrograph ×25. Numerous small hemorrhages surrounded by normal lung tissue, accounting for fine densities on necropsy films.

and congested. The mesenteric lymph nodes were numerous and large.

In the thoracic cavity there were no adhesions of either the pleural or pericardial sacs and there was no free fluid. Both lungs seemed a little distended. Externally their color was pink, the pleurae showing no hemorrhages. On section there were minute petechial hemorrhages sprinkled everywhere throughout the parenchyma. The intervening tissue was air-containing and crepitant. The bronchi and trachea had a congested lining and contained dark red blood-stained mucus. The tracheobronchial lymph nodes were not enlarged.

Although a special search was made, no hemorrhages could be found in other viscera.

Histology. Sections of the colon showed infiltration of the mucosa with round cells and necrosis of its superficial portion.

Sections of the ileum showed the mucosa to be necrobiotic or largely absent, with only a trace of the crypts remaining and these were dilated and irregular. The underlying Peyer's patches showed marked proliferation of the germinal centers, and edema and hyperemia of the follicles.

Sections of the lungs (Fig. 2) showed small hemorrhages scattered throughout the parenchyma, with normal lung tissue between the hemorrhagic areas. No evidence of consolidation could be found and there was no evidence of the inflammatory reaction about the individual hemorrhagic areas.

Bacteriology. Stool culture:—*B. dysenteriae*, Flexner. Pus from bronchus:—*Staphylococcus aureus* and large gram-positive bacilli. Lung parenchyma:—*Staphylococcus aureus* and *B. coli*.

Pathologic Diagnosis. Acute bacillary dysentery (Flexner); hyperemia and edema of the mucous lining of the ileum and colon; enlargement of mesenteric lymph nodes; fatty changes in the liver; hemorrhagic foci in the pulmonary parenchyma; hemorrhagic tracheobronchitis.

Case II. White female, aged twenty-five days.

Fig. 3. Case II. Necropsy roentgenogram. Large irregular shadows produced by hemorrhages coalescing to produce whorl-like patterns. Note similarity to certain cases of bronchopneumonia (Fig. 5).

This infant was admitted to the hospital six days before death with the history of a bloody diarrhea of ten days' duration. Vomit-

ing had been present at the onset. The previous history was that of a normal birth. Delivery had been at full-term; birth weight was 7½ pounds. There had been no convulsions, cyanosis, or hemorrhages noted. A cow's milk formula had been used since birth. A few days before death there was a bilateral otitis media which had yielded pus, but both ears had healed before death occurred. At no time had there been symptoms of pulmonary involvement. The temperature had never been elevated more than 2 degrees.

The roentgenogram (Fig. 3) of the chest taken after death showed unusual irregular soft tissue densities scattered throughout the lung fields, confluent in places. The heart shadow did not appear enlarged or abnormal in shape. The shadow of the upper mediastinal structures was not considered abnormal.

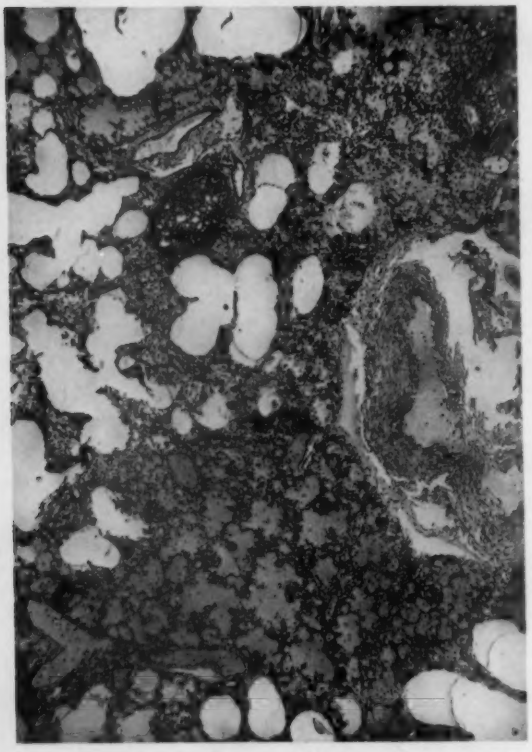


Fig. 4. Case 11. Photomicrograph ×65. Individual hemorrhages filling several alveoli and accounting for striking shadows on necropsy film.

Necropsy. The gastrointestinal tract showed many tiny fresh-looking ulcers, varying from 0.5 to 2 mm. in diameter, in the region of the Peyer's patches. The intervening mucosa was normal. The mesenteric and ileocecal lymph nodes were enlarged.

On opening the thoracic cavity no exudate or adhesions were found. The lungs were

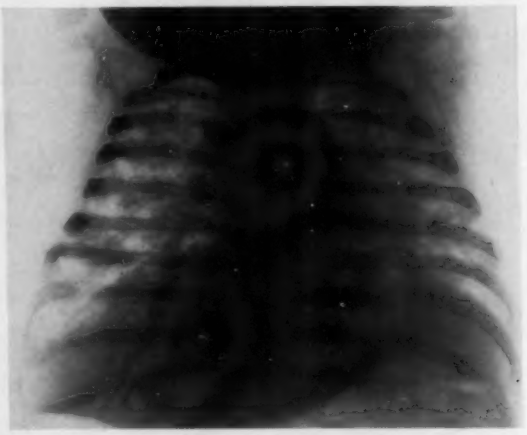


Fig. 5. Necropsy film. Case of focal hemorrhagic pneumonia secondary to extensive furunculosis (*Staphylococcus aureus*). Note marked similarity of roentgen densities to Case 11 (Fig. 3).

mottled with dark red spots against a normal pink background. On section, the same pattern was found to extend throughout both lungs. The lesions seemed to consist of localized hemorrhages, apparently of recent origin, as they did not feel indurated and the lobules were not shrunken. Little blood oozed from the cut surface. There was mild congestion of the mucosal lining of the bronchi and trachea. The mediastinal nodes were not enlarged.

The only other abnormal changes found were those of a mild hyperemia of all the viscera. The lines of ossification of the ribs were straight and regular, revealing no evidence of rickets or scurvy. The brain was not examined.

Histology. Sections of the lung (Fig. 4) showed innumerable alveoli containing blood as well as hemorrhages into the lung tissue, with blood still liquid in places. There was no evidence of round cell infiltration. The bronchi seemed normal.

Section of the ileum showed the mucosa and outer part of the submucosa absent in many places. The deeper part of the submucosa was necrobiotic and infiltrated with wandering cells. The muscularis was not affected.

Bacteriology. Cultures of pus from the lung and from the throat showed a heavy growth on blood agar plate, from which only bacilli of

the colon-aerogenes group, some producing hemolysis, could be isolated.

In cultures of intestinal contents, only bacilli of the colon-aerogenes group were found. Two restreakings yielded no different results.

In cultures of the heart's blood, bacilli of the colon-aerogenes group (non-hemolytic) were found.

Pathologic Diagnosis. Malnutrition; dehydration; multiple hemorrhages in the lung; focal ulcerations in Peyer's patches of the ileum; congestion of all viscera; septicemia, *B. coli.*

INTERPRETATION

Few pulmonary lesions show a more general distribution of uniform fine densities on the roentgenogram than does miliary tuberculosis in children. However, that similar shadows varying from mere specks to 2 mm. in diameter may be produced by fine hemorrhages in the lungs is illustrated by the 2 cases here reported. They resemble miliary tuberculosis in that they both can produce snowflake-like densities on the post-mortem roentgenogram. However, hemorrhages of this type have not been observed on roentgenograms made during life. A study suggests that they occur while death is taking place and consequently, for practical purposes, the fine shadows they produce need not be confused with other conditions causing a similar appearance on the films made during life.

Fig. 6. Photomicrograph ×20. Case illustrated in Figure 5. Areas of consolidation accounting for roentgen shadows. Note the proportion of "solid" areas to air-containing spaces, similar to that produced by hemorrhages in Case II (Fig. 4), accounting for the roentgen appearance.

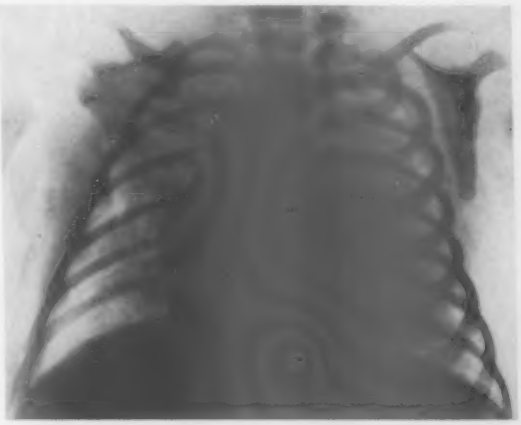


Fig. 7. Widespread interstitial pneumonia secondary to infection of navel (*Streptococcus hemolyticus*) in child a week old. Smooth, fine-grained clouding of both lung fields, only slightly unlike the more or less discrete shadows of generalized small hemorrhages (Fig. 3). Note lung fields are incompletely involved and separate shadows of hemorrhages are not present.

When the individual hemorrhages are 1 to 2 mm. in diameter, presenting whorls or crescentric shadows of "miliary" distribution on the film, certain forms of bronchopneumonia and other rarer conditions are apt to be considered. For example, pneumonia produced by the *Staphylococcus aureus* resembles the larger type of scattered hemorrhages (Case II) when the small areas of consolidation (Figs. 5 and 6) tending to produce abscesses are extensively scattered throughout both lungs. Many cases of this kind in epidemic form were

observed following influenza in 1918. Widespread distribution of similarly fine, consolidated, or necrotic areas in the lungs are found sporadically as the result of

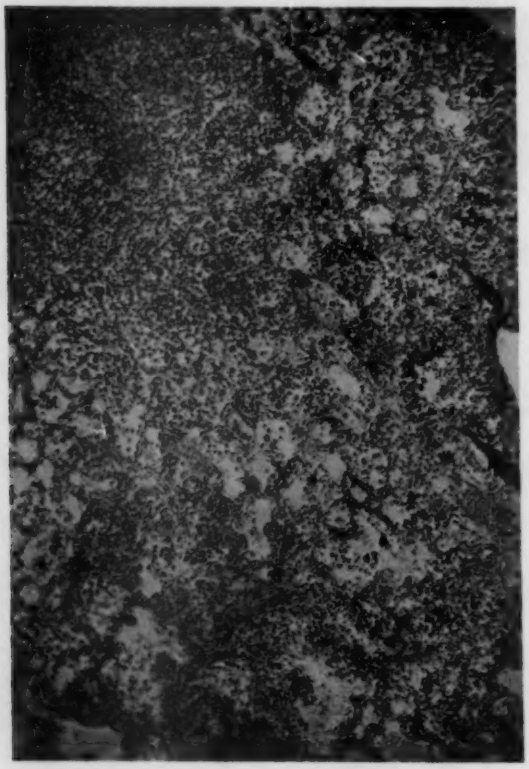


Fig. 8. Photomicrograph ×65. Same patient as in Figure 7. Note smooth transition from partially air-containing areas to areas of greater consolidation, which explains the almost general clouding of both lung fields on necropsy film.

blood-borne infections. In children, death usually follows closely upon the development of the abscesses, and the widespread scattered densities throughout the lung fields are therefore seldom encountered on the film during life. The only cases of this kind which I have seen with this distribution were observed on the necropsy film. In one case the film taken twenty-four hours before death did not show generalized shadows, but they were present on the film after death.

In cases of influenza, bilateral and multilobar pneumonia has been seen which presented widespread fine discrete shadows on the roentgenogram, but, as a rule, the areas were not uniform in density, in distribution, in size, or in form.

Interstitial forms of pneumonia seldom have the roentgen appearance of fine uniform densities scattered throughout both lung fields. When this is approximated (Figs. 7 and 8), a dust-like cloudiness may be produced on the roentgenogram.

In pulmonary edema, where there is saturation with serous fluid exuding from the capillaries, there may occur a general blotting out of air in the lung. Here the perfect water-like translucent smoothness of the shadow is more or less conclusive evidence of the true condition. Usually, when this involvement is not so extensive, the smooth shadow reaches out only a short distance from the hila and in this way simulates hypostasis or congestion, frequent findings on the necropsy film, but bears little resemblance to the widespread figured patterns of fine pulmonary hemorrhages.

In certain congenital disturbances in lipoid metabolism (Niemann-Pick's disease, xanthomatosis, and Gaucher's disease), the alveolar spaces may contain large numbers of foam cells evenly scattered throughout the lungs producing a roentgen pattern simulating generalized fine foci of a blood-borne infection or hemorrhages. This condition in young children is frequently associated with an enlarged liver and spleen or bone defects, which should suggest the likelihood of local manifestations of a general disorder of this kind rather than "miliary" pulmonary hemorrhages.

In cases of eosinophilic leucemia, the leucemic infiltrations may appear as uniformly faint shadows of varying size scattered throughout the lungs, resembling closely the shadows of numerous fine hemorrhages as seen at necropsy.

CONCLUSION

Evenly spaced fine hemorrhages in the lungs of young children can produce a

roentgenologic appearance after death closely resembling the shadows of a relatively early miliary tuberculosis. These hemorrhages apparently occur as death takes place and have not been found on roentgenograms made during life. A mistaken interpretation could easily be made where the necropsy film is relied upon for diagnostic purposes. Minute hemorrhages in a child two and a half years of age and larger hemorrhages in an infant twenty-five days old are reported. The roentgen pattern of the larger hemorrhages may simulate those of other pulmonary conditions, as well as miliary tuberculosis.

For the careful check of the post-mortem findings I am indebted to Drs. I. J. Wolman and W. G. Hibbs.

The case shown in Figure 5 was used by permission of Profs. P. C. Hodges and B. Hamilton of the University of Chicago Clinics, as it more closely resembled the roentgen pattern of Case 11 than any of my own cases.

FURTHER CHOLECYSTOGRAPHIC STUDIES IN THE LATE MONTHS OF PREGNANCY*

By LESTER LEVYN, M.D., EDGAR C. BECK, M.D., *and* A. H. AARON, M.D.
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THE relationship of pregnancy to gallbladder disease was recognized in the Sixteenth Century by Ettmuller.[8] He directed attention to the frequency of the occurrence of biliary colic during pregnancy and after childbirth.

Huchard,[12] whose article appeared in 1882, stressed the frequent incidence of gallstones in gravid women. Since then many articles have been published making available an abundance of statistical data on the subject to support this observation.

Surgical figures from various sources indicate that from 70 to 90 per cent of women operated on for gallstones have borne children.

It occurred to us that probable alterations in gallbladder function during the late months of pregnancy might be demonstrated by cholecystographic studies. In a previous communication[13] in 1928, we presented the results of cholecystographic examinations in 17 young primiparas, in whom there was no evidence of biliary tract disease. We were impressed by the observation that, in this small group, the gallbladder failed to visualize in 7 instances. The purpose of this presentation is to report further cholecystographic studies in 22 additional cases, a total of 39. In this last group plasma cholesterol estimations were also determined. We were able to repeat the cholecystographic and cholesterol studies in 7 of these cases after delivery.

VISUALIZED GROUP

Our findings in humans differ from the work of Mann and Higgins[14] who concluded from experiments in certain species of animals that emptying of the gallbladder is delayed or that it does not empty at all during pregnancy.

In our group the gallbladder was visualized in 19 of the 39 cases. There was no delay in the time of appearance of the shadow. The Boyden[4] meal was administered to all, and in each instance the gallbladder shadow was markedly diminished in size or complete emptying occurred in from one to two hours. No change in the size of the viscus was noted as compared with non-pregnant women.

In 17 cases the gallbladder was displaced upwards and to the right, and pressure defects were seen in several. Crossen and Moore[6] likewise reported a similar modification in position, in their studies of pregnant women.

NON-VISUALIZED GROUP

The gallbladder failed to visualize in 20 of the 39 cases studied. It was apparent from the position of the fetus that the uterus approximated the region of the liver and gallbladder. We do not believe that mechanical pressure is responsible for shadow failure owing to the fact that in the 19 visualized cases the uterus occupied a similar position in its relationship to the liver and gallbladder.

At the present time we are unable to offer any explanation to account for the failure of the gallbladder to visualize in a group of normal young primiparas considering that in an almost equal number shadows were obtained under similar conditions.

We therefore doubt until further, more definite proof is available that pressure on the gallbladder and ducts, caused by the greatly enlarged uterus, is responsible for shadow failure.

It is not reasonable to believe that the technical difficulty caused by projection of the rays through the increased volume of the abdominal contents during the late

* Read at the Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

months of pregnancy is responsible for non-visualization because in many cases in which visualization did occur, shadows with excellent definition were obtained even in obese patients.

GROUP STUDIED POST PARTUM

We were able to repeat the tests in 7 cases at various periods following delivery. In 3 whose gallbladders were not visualized before delivery shadows were obtained after. In 2 the shadows were normal as to density, and in the third the density was much fainter.

In 3 cases excellent visualization occurred before delivery, whereas after birth of the babies the density was greatly diminished in 2 instances, and no shadow resulted in the third. One failed to visualize both before and after delivery.

We are reluctant to draw any conclusion from this small group, but one is impressed by the fact that alterations of gallbladder function occur during pregnancy and following delivery.

PLASMA CHOLESTEROL DETERMINATIONS

This part of the investigation was conducted to determine whether or not there was any relationship between the plasma cholesterol findings and any alteration in gallbladder function as shown by cholecystography.

Hypercholesterolemia, in the later months of pregnancy, was shown by Herrmann and Neumann[11] in 1912. Their figures showed that the cholesterol in the plasma was 68.6 per cent over normal at term.

Chauffard, Laroche and Grigaut[5] demonstrated that during the first six or seven months of pregnancy the serum cholesterol may be increased, and that in the last two months an increase of serum cholesterol is the rule.

Oser and Karr[16] stated that the blood cholesterol is increased during pregnancy.

Slemons and Stander[19] concluded that during the latter months of pregnancy the fats and the lipoids in the blood gradually increase, and that at full term the concentration is at least one-third greater than the accepted normal for women.

They considered normal those readings between 200 and 250 mg. per 100 c.c., and in their series of pregnant women the results varied from 190 to 330 mg., total cholesterol. They think that the increased lipoids have something to do with the storage for lactation.

Denis,[7] in a group of early pregnancies, found normal figures.

Tyler and Underhill[20] concluded that cholesterol, cholesterol esters, and lecithin increase gradually until term, when each is roughly one-third higher than at three months. They stressed the fact that in other conditions where cell multiplication goes on rapidly, there is a hypercholesterolemia.

Ferguson and Priestley[9] followed 11 cases of their series for one and one-half years after delivery. They reported that in several of these cases hypercholesterolemia persisted.

The association of pregnancy and gallstone formation is well recognized, and many theories have been advanced to explain this phenomenon. It was shown by Aschoff and Bacmeister[1] that the majority of gallstones are constituted largely of cholesterol, and they suggested a derangement of the body lipoid metabolism as one of the main factors in the etiology of their formation. An increase in the biliary cholesterol combined with stasis and concentration of the bile in the gallbladder are factors which, according to them, are sufficient to cause crystallization and precipitation of cholesterol.

Chauffard, Laroche and Grigaut[5] stated that gallstones are partly produced because of the large amount of cholesterol in the blood and bile during pregnancy. They also found that hypercholesterolemia persisted after pregnancy and was, therefore, useful in the diagnosis of gallstones. This work was confirmed by others, including Bell,[2] Wilensky and Rothschild,[21] and Rothschild and Rosenthal.[18]

Myers[15] could not confirm these results,

and found normal blood cholesterol readings in most of the cases he examined.

Peters and Van Slyke[17] stated that most recent studies have failed to establish any relation between gallstones and hypercholesterolemia.

METHOD

Five cubic centimeters of blood was taken for the cholesterol determination three hours after the ingestion of a low fat meal. The method of Bloor[3] was used. There is a divergence of opinion as to the normal of the cholesterol values of the blood. Many writers place the normal between 100 and 160 mg. Gardner and Gainsborough[10] stated that the reports of hypercholesterolemia must be reviewed critically. They contend that a precise figure is dangerous because the plasma cholesterol content varies within wide limits in normal individuals. They advocate the estimations of the free cholesterol and the cholesterol esters in every case. Peters and Van Slyke have adopted the figures of 100 to 230 mg. per 100 c.c. of total plasma cholesterol as representing the normal range.

We have accepted these figures as a basis for comparison.

Our group of 22 cases, in which cholesterol estimations were made, averaged 214 mg. per 100 cc. of blood.

TABLE I

CHOLESTEROL READINGS AND VISUALIZED GROUP

A HYPERCHOLESTEROL GROUP		B NORMAL CHOLESTEROL GROUP	
Case No.	Cholesterol Value	Case No.	Cholesterol Value
5	247	1	102
7	255	6	200
8	264	12	108
15	378	21	173
		22	143

In the visualized group our figures show the cholesterol values above the accepted high normals in 4 cases. Five were within the normal range.

In this series there is no relation between the cholesterol values and the ability of the gallbladder to concentrate the dye.

TABLE II

CHOLESTEROL READINGS AND NON-VISUALIZED GROUP

A HYPERCHOLESTEROL GROUP		B NORMAL CHOLESTEROL GROUP	
Case No.	Cholesterol Value	Case No.	Cholesterol Value
10	260	2	138
	-	3	222
		4	140
24	286	11	185
		13	222
		14	228
		16	224
		17	161
		18	225
		19	177
		20	228
		23	230

In 2 cases (10 and 24) increased cholesterol values were found. In 12 cases the readings were normal. It is therefore evident that no relationship exists between the plasma cholesterol values and failure of the gallbladder to concentrate the dye.

CHOLESTEROL READINGS, CHOLECYSTOGRAPHY, BEFORE AND AFTER DELIVERY

Case 1 had a four plus visualization in the ninth month of pregnancy with a plasma cholesterol of 102 mg., whereas, two and one-half months after delivery, two plus visualization with a plasma cholesterol of 238 mg. resulted.

Case 5 had a four plus visualization in the seventh month of pregnancy with a plasma cholesterol of 247 mg., and five weeks after delivery a plasma cholesterol of 225 mg., with a two plus visualization.

Case 7 had a four plus visualization in the eighth month of pregnancy with a plasma cholesterol of 255 mg. Six weeks after delivery no shadow resulted and the plasma cholesterol was 268 mg.

Case 3 did not visualize before delivery with a plasma cholesterol of 222 mg. Likewise there was no shadow after delivery and the plasma cholesterol was 248 mg.

Case 4 failed to visualize before delivery. The plasma cholesterol was 140 mg., whereas after delivery a one plus visualization resulted with a plasma cholesterol of 198 mg.

Case 10 did not visualize in the eighth month of pregnancy. The plasma cholesterol reading was 260 mg. Four plus visualization occurred six weeks after delivery, and the plasma cholesterol was 256 mg.

Case 17 did not visualize before delivery and the plasma cholesterol was 161 mg. After delivery a four plus visualization occurred with the plasma cholesterol 214 mg.

TABLE III

CHOLESTEROL READINGS, CHOLECYSTOGRAPHY, BEFORE AND AFTER DELIVERY

Case No.	Visualization Before Delivery	Cholesterol Before Delivery	Visualization After Delivery	Cholesterol After Delivery
1	4	102	2	238
5	4	247	2	225
7	4	255	Non-Vis. o	268
3	Non-Vis. o	222	Non-Vis. o	248
4	Non-Vis. o	140	1	198
10	Non-Vis. o	260	4	256
17	Non-Vis. o	161	4	214

o, 1, 2, 3, 4 indicate degree of density of visualization.

It is obvious from this group, in which cholesterol determinations and cholecystographic studies were conducted before and after delivery, that it is impossible to form any conclusions because there was no constancy in the findings. Nevertheless, one is impressed by the failure of visualization and alterations in the degree of density of the gallbladder shadows in young primiparas, in the late months of pregnancy and within six weeks after delivery.

CONCLUSIONS

1. The gallbladder failed to visualize in 20 instances in a group of young primiparas who had no history or clinical evidence of biliary tract disease.

2. Visualization resulted in 19 cases and the gallbladder occupied a high position in the abdominal cavity in all, and in many instances pressure defects were demonstrable.

3. The consistently high position and displacement of the gallbladder to the right due to pressure of the enlarged uterus and increased intra-abdominal tension did not delay the appearance time of the shadow nor interfere with response to the fat meal.

4. There was no appreciable difference in the plasma cholesterol values between the visualized and non-visualized groups.

5. There was no parallelism between the cholesterols and cholecystograms compared before and after delivery.

6. In 39 primiparas the intravenous injection of sodium tetraiodophenolphthalein produced no reactions other than a transitory sensation of warmth in 8 cases. There were no harmful effects on the mother, fetus, or the course of the pregnancy.

We desire to express our gratitude to Professor Francis C. Goldsborough, of the School of Medicine of the University of Buffalo, and to the personnel of the Ingleside Home for their hearty cooperation.

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ILEOCECAL TUBERCULOSIS AND THE DOUBLE CONTRAST ENEMA EXAMINATION*

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IN A preliminary report,[1] a review was made of the recent advances in the diagnosis of ileocecal tuberculosis and the rôle played by the two main roentgen methods of study, namely, the mouth meal and the single contrast enema of barium sulphate suspension. Special reference was made to the use of the newer double contrast barium enema examination in these studies and now, in this report, an analysis is made of 102 consecutive cases, studied completely by the mouth meal, simple and double contrast enemas. These studies were made on patients admitted to Eagleville Sanatorium, Eagleville, Pa.; all suffering with pulmonary tuberculosis, with tubercle bacilli in the sputum. The pulmonary processes ranged from incipient to far-advanced lesions and were of diverse types. Many of the advanced cases have died and were autopsied during these studies, affording us an opportunity to check the accuracy of our roentgen findings. Very little was learned, either by surgery or autopsy, in those cases of *early* intestinal tuberculosis where we were so anxious to check our roentgen findings. We had to content ourselves with correlating the post-mortem and roentgen findings of fresh or early processes, often quite distal to the ileocecal areas, with those cases which came to autopsy in which the tuberculous ileocecal lesions were most frequently past the early stages. Our roentgen findings were further evaluated by studies of colons with early lesions removed from cadavers at the Philadelphia General Hospital, which were then examined by both enema methods.

Sampson has painstakingly advanced the application and reliability of the mouth meal examination in the roentgen diagnosis of secondary ileocecal tuberculosis. We used his technique in the study of this series of patients and then checked the findings with those obtained with the single and double contrast enemas, the technique of which was modified from that first advocated by Fischer.

Considerable experience and training are necessary in the interpretation of the mouth meal films and unless one has a broad knowledge of normal roentgen appearances of the intestinal tract at different intervals after the mouth meal, many pitfalls present themselves. The diagnosis of early ileocecal tuberculosis by the mouth meal method depends almost solely on abnormal changes of motility of the barium column through the affected segments of bowel. Hypermotility in a segment of intestine in a tuberculous patient, revealed rather consistently in a series of films made between the seventh and tenth hour after ingestion, forms practically the keystone in the diagnosis of ileocecal tuberculosis, as worked out by Brown and Sampson.

In this series of 102 cases, 58 were negative and 44 were positive for evidence of secondary intestinal tuberculosis. Of the positive cases, 29 presented roentgen changes by the mouth meal examination, characteristic enough to establish the roentgen diagnosis, but 42 cases, about 30 per cent more, revealed roentgen signs by the enema studies from which we could make the diagnosis. On the other hand, in only 2 cases did the mouth meal studies reveal positive findings not obtainable by the enema examinations and in these cases, the lesions were confined practically to the jejunum and ileum. These lesions were also

[1] Gershon-Cohen, J. The diagnosis of early ileocecal tuberculosis. Am. J. Roentgenol. & Rad. Therapy, 1930, *24*, 367–388.

* These studies were made at the Isaac Paley Memorial Laboratory of Eagleville Sanatorium, Eagleville, Pa. (Dr. A. J. Cohen, Medical Director.)

FIG. 1*a*. A case of early ileocecal tuberculosis. Patient is a female, aged twenty-three, with minimal proliferative tuberculosis of the right upper lobe, tubercle bacilli in sputum, Gaffky 1, with pulmonary symptoms of five months' duration. Intermittent digestive disturbances for the past three months, chiefly intermittent abdominal distention, constipation and diminished appetite. Studies with the mouth meal reveal no evidence of involvement of the ileocecal area while the barium enema studies reveal the presence of irritability, spasticity, hyperperistalsis and anastalsis in the cecum. This case was therefore regarded as having minimal tuberculous inflammation in the cecum. Five hours after mouth meal, a moderate gastric residue is present, the rest of the opaque contents being distributed in the duodenum, jejunum, ileum and colon, the head of the column having reached the hepatic flexure. Terminal ileum not filled. Ceco-colon irregularly filled.

probably old, having produced some stenosis and contraction of the lumen which caused stasis and dilatation in the proximal segments. The 15 cases that we diagnosed positive by only the enema findings were significantly only those cases with early lesions. It is true that abnormal changes, usually hypermotile in nature, were seen in the roentgenograms of the mouth meal studies in this group, but these changes were not sufficiently constant or localized in the entire series of films to allow a trustworthy positive diagnosis. One was more inclined to regard them as possibly only borderline cases. Considerable broad experience is undoubtedly necessary for the correct interpretation in this group of cases and in other hands most of these cases, studied by the mouth meal, might be regarded as falling in the positive class. At any rate, we were more convinced with enema findings because these were easily obtained, definite and recordable. The colon with early acute inflammation seems to us to react in a manner more easily discovered by the enema examination than the mouth meal method.

The roentgen signs found in this group by enema examinations are localized spasm, intermittent hyperperistalsis and anastalsis, localized pain and tenderness,

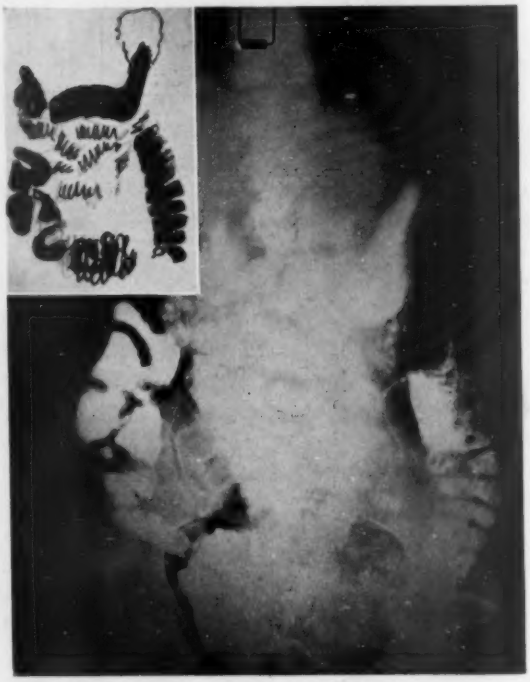

FIG. 1*b*. Same patient six hours after ingested meal. Terminal ileum well filled, the opaque contents being evenly distributed in the ceco-colon.

irregularity in the distribution of the residual opaque coating of barium on the inflamed portions of intestinal mucosa (visible only in the double contrast films), and least important, incompetency of the ileocecal valve. Ulcers can be detected, but only rarely. All these signs may not be found at the same time in any one case, neither are they of equal significance nor their frequency of occurrence invariable. One must also remember that these findings are not all pathognomonic of tuberculosis since inflammation from other causes can produce quite similar changes.

In the moderate and advanced cases of ileocecal tuberculosis, both methods of examination were found to yield unequivocal signs, only we gained a better insight into the extent and amount of involvement by the enema studies than by the mouth meal examinations. An analysis of the roentgen findings after barium enema was therefore made to evaluate their usefulness (Table 1).

Fig. 1*c*. Same patient eight hours after ingested meal. Slight gastric and duodenal residue, the rest of the opaque contents being distributed in the terminal ileum and colon, the head of the column having reached the splenic flexure. Terminal ileum apparently normally filled. Cecum and ceco-colon the seat of rather uniform heavy residue.

Fig. 1*d*. Same patient. Barium enema. No apparent filling defects in the cecum. Ileocecal valve competent, but there was intermittent spasticity, hyperperistalsis and anastalsis in the cecum.

Spasm. One does not expect to find persistent or intermittent localized spasm in the normal colon. Spasm and irritability of segments in the lower left colon are frequently encountered and although probably abnormal, one finds difficulty in attaching significance to the finding. It is the

Table I

Ileocecal Tuberculosis Methods of Study		
Cases Studied	102	
Positive cases (as determined by both Sampson and double contrast enema studies)	44	
Positive cases (as determined by enema studies alone)	42	96%
Positive cases (as determined by Sampson studies alone)	29	66%

TABLE II

SPASM (44 POSITIVE CASES) (58 NEGATIVE CASES)

	Single Contrast Enema. Relation of Spasm to Location								Double Contrast Enema. Relation of Spasm to Location							
	Positive				Negative				Positive				Negative			
	Tonic	Intermittent	Total	Percentage	Tonic	Intermittent	Total	Percentage	Tonic	Intermittent	Total	Percentage	Tonic	Intermittent	Total	Percentage
Cecum	6	34	40	91.0	6	14	20	34.4	6	19	25	56.8	0	3	3	5.1
Ceco-colon	1	16	17	38.6	0	2	2	3.4	3	7	10	22.7	0	2	2	3.4
Transverse	1	6	7	15.9	0	10	10	17.2	0	0	0		0	1	1	1.7
Descending	0	2	2	4.4	0	7	7	12.0	0	0	0		0	2	2	3.4
Sigmoid	0	7	7	15.9	1	5	6	10.3	0	0	0		0	2	2	3.4

	Relation of Location to Spasm										Relation of Location to Spasm									
	Positive					Negative					Positive					Negative				
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Cecum	Ceco-colon	Transverse	Descending	Sigmoid
Total	40	17	7	2	7	20	2	10	7	6	25	10	0	0	0	3	2	1	2	2
Percentage	91.5	38.6	15.9	4.4	15.9	34.4	3.4	17.2	12.0	10.3	56.8	22.7	—	—	—	5.1	3.4	1.4	3.4	3.4

Positive Cases	44		Negative Cases	58		
Spasm present in	36	81.3%	Spasm present in	21	36.2%	
Spasm absent in	8	18.1%	Spasm absent in	37	63.7%	
Positive Cases	44		Negative Cases	58		
Spasm present in	26	59.0%	Spasm present in	8	13.7%	
Spasm absent in	18	40.0%	Spasm absent in	50	86.2%	

left colon that is generally involved in that rather broad class of "spastic" or "irritable" colons of neurogenic origin and in other diverse infectious processes like chronic ulcerative colitis, dysentery, amebiasis, chronic cathartic granular or follicular colitis and diverticulosis and diverticulitis. But the right colon, especially the ileocecal area, is the most usual site for tuberculous invasion. It is only exceptional that pathological processes, usually affecting the left colon, are found in the right colon and when they do occur there, rarely are they so advanced as in the left colon. Therefore, when one finds spasm or irritability of a segment of colon in the enema examinations, its association with some underlying abnormality is to be regarded as a probability and if its occurrence is in the ileocecal area, especially in a patient suffering with pulmonary tuberculosis

Fig. 2*a*. A case of late ileocecal tuberculosis. Patient is a male, aged sixty-three, with advanced fibro-ulcerative cavernous tuberculosis of both upper lobes. Film five hours after ingested meal. Considerable gastric and duodenal residue, the rest of the opaque contents being distributed in the terminal ileum and colon, the head of the column having just passed into the ceco-colon.

Fig 1*c*. Same patient. Double contrast enema. Note the irregularity of the residual mucosal barium coating in the cecum as contrasted with the uniform barium coating in the ceco-colon.

with tubercle bacilli in the sputum, then tuberculosis in these intestinal segments must be strongly suspected (Table II).

Table II shows that spasm was found almost three times more frequently in the positive than in the negative cases when studied by the single contrast enema and almost five times more frequently with the double contrast enema. It is not the mere presence of spasm, however, but its location which is the more significant in the formulation of a diagnosis. Thus, one notes its occurrence in the single contrast enema in 40, or 91.5 per cent, of the positive cases in the cecum and with rapidly decreasing frequency in the distal segments. In the double contrast enema studies, its frequency of occurrence is generally less, but also in a significant manner, namely, in 25,

TABLE III

HYPERPERISTALSIS

	Single Contrast Enema. Relation of Hyperperistalsis to Location				Double Contrast Enema. Relation of Hyperperistalsis to Location			
	Positive		Negative		Positive		Negative	
	Intermittent or Paroxysmal	Percentage	Intermittent or Paroxysmal	Percentage	Intermittent or Paroxysmal	Percentage	Intermittent or Paroxysmal	Percentage
Cecum	20	45.5	4	6.8	7	15.9	0	
Ceco-colon	19	43.1	5	8.6	4	9.0	1	1.7
Transverse	13	29.5	10	17.2	0		1	1.7
Descending	7	15.9	7	12.6	0		2	3.4
Sigmoid	3	6.8	5	8.6	0		0	

Relation of Location to Hyperperistalsis												
Positive						Negative						
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid		Cecum	Ceco-colon	Transverse	Descending	Sigmoid
Total	20	19	13	7	3	Total	4	5	10	7	5
Percentage	45.4	43.1	29.5	15.9	6.8	Percentage	6.8	8.6	17.2	12.6	8.6

Positive Cases	44	
Hyperistalsis present	33	75%
Hyperistalsis absent	11	25%

Negative Cases	58	
Hyperistalsis present	17	29.3%
Hyperistalsis absent	41	70.6%

Relation of Location to Hyperperistalsis												
Positive						Negative						
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid		Cecum	Ceco-colon	Transverse	Descending	Sigmoid
Total	7	4	0	0	0	Total	0	1	1	2	0
Percentage	15.9	9.0				Percentage		1.7	1.7	3.4	

Positive Cases	44	
Hyperistalsis present	9	20.4%
Hyperistalsis absent	35	79.5%

Negative Cases	58	
Hyperistalsis present	3	5.1%
Hyperistalsis absent	55	94.8%

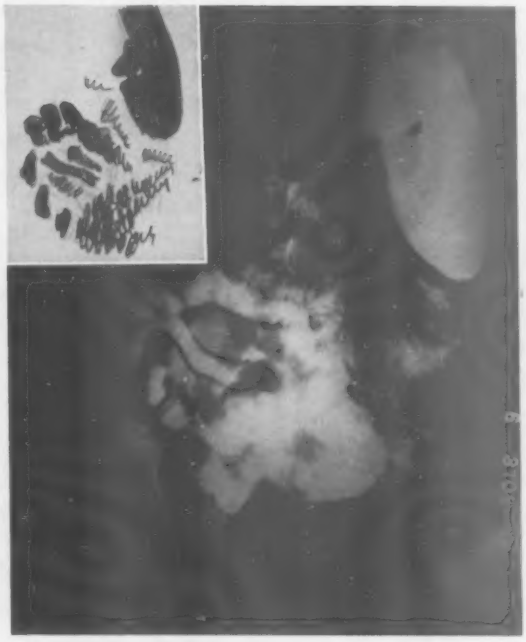

FIG. 2*b*. Same patient six hours after ingested meal. The head of the column has reached the hepatic flexure but the terminal ileum and proximal ceco-colon are poorly and irregularly filled.

FIG. 2*c*. Same patient eight hours after ingested meal. The head of the column has reached the splenic flexure. The terminal ileum and ascending colon are still poorly and irregularly filled.

or 56.8 per cent, in the cecum and in 10, or 22.7 per cent, in the ceco-colon. This is in rather marked contrast to the findings in the 58 negative cases where spasm was revealed much more frequently in the left than in the right colonic segments, especially in the double contrast enema studies.

Hyperperistalsis and Anastalsis. It is notoriously rare to see colonic mass peristalsis during a mouth meal examination. Evidence of segmental hyperfunction resulting in increased motility is far more frequently obtained only from the serial roentgenograms than by the roentgenoscopic examination, when using the mouth meal method. During the enema examinations, however, its occurrence is frequently noted as seen in Table III. What was said about spasm applies more or less directly to the occurrence and location of abnormal peristalsis during the enema examinations. It occurred most frequently in the cecum and ceco-colon in early ileocecal tuberculosis.

One of the most common omissions in the enema study of the colon is failure to examine the patient after evacuation. This is fortunately impossible with the double contrast enema studies. It is natural not to expect an inflamed irritable segment of colon to retain injecta and in Table IV the cecum was the site of retained opaque injecta twice as frequently in the negative as in the positive group. If only the early positive cases were compared with the negative group, the difference should be even more striking. In late ulcerative or hyperplastic tuberculous colitis with much fibrosis, scar tissue formation and rigidity of the colonic walls, it is almost the rule to find a residuum of opaque contents in the involved segments. More generally, it is only in the early positive cases that irritability, hyperperistalsis and hypermotility of the involved segment is present and thus, more or less complete evacuation of the opaque injecta is seen in the affected areas during the intermediate examination.

Abnormal Changes in Residual Mucosal Coating of Barium. In a normal colon, the double contrast enema roentgenograms reveal a uniform coating of residual barium suspension on the colonic mucosa, but in transudative muco-spastic conditions or in inflammatory exudative processes, there are rather characteristic changes in this uniformity. This is one of the most helpful of aids furnished by the double contrast studies. One relies on it more and more as his experience broadens. In Table v, of the 44 positive cases, 35, or 79.5 per cent, reveal some change in the uniformity of residual mucosal coating in the cecum and 19, or 43.1 per cent, in the ceco-colon; this is a remarkable contrast to its occurrence in 58 negative cases where it was noted in only 4 cases, or 6.8 per cent, in the cecum and ceco-colon. The changes of uniformity of coating depend on the nature and distribution of the underlying pathological changes. It seems unfortunate that ulcer is so rarely visible. This occurs only when a collection of barium residuum gathers under the overhanging edges or in the crater. Usually, a mosaic streaky arrangement of the residuum is visible in an inflamed area, making a rather sharp contrast to the uniformly coated adjacent normal segments. The marginal profiles instead of being sharply contrasted, etched-like white lines, as in the normal segments of colon, vary irregularly in the degree of visible distinctness, smoothness and continuity. Although these changes are no more characteristic for tuberculous than other inflammatory forms of colitis, except possibly chronic ulcerative colitis, the location of these changes helps in the diagnosis because

TABLE IV

INTERMEDIARY STUDIES

Relation of Residual Stasis to Location

Positive			Negative		
	Total	Percentage		Total	Percentage
Cecum	10	22.7	Cecum	26	44.8
Ceco-colon	18	40.9	Ceco-colon	31	53.3
Transverse	9	20.4	Transverse	12	20.6
Descending	20	45.5	Descending	24	41.3
Sigmoid	11	25.0	Sigmoid	17	29.3
Rectum	8	18.0	Rectum	12	20.6
Ileum	5	11.4	Ileum	11	18.9

Relation of Location to Residual Stasis

Positive								Negative							
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum	Ileum		Cecum	Ceco-colon	Transveres	Descending	Sigmoid	Rectum	Ileum
Total	10	18	9	20	11	8	5	Total	26	31	12	24	17	12	11
Percentage	22.7	40.9	20.4	45.5	25.0	18.0	11.4	Percentage	44.8	53.3	20.6	41.3	29.3	20.6	18.9

Positive Cases	44		Negative Cases	58
Residue present in	36	75%	Residue present in	46	79.3%
Residue absent in	12	25%	Residue absent in	12	20.7%

TABLE V

CHANGES IN UNIFORMITY OF RESIDUAL BARIUM COATING ON MUCOSA IN DOUBLE CONTRAST FILMS

Relation of These Changes to Location

Positive			Negative		
	Total	Percentage		Total	Percentage
Cecum	35	79.5	Cecum	4	6.8
Ceco-colon	19	43.1	Ceco-colon	4	6.8
Transverse	8	18.1	Transverse	7	12.0
Descending	10	12.7	Descending	7	12.0
Sigmoid	7	15.9	Sigmoid	3	5.1
Rectum	0	0	Rectum	3	5.1

Relation of Location to Changes in Uniformity of Coating

Positive							Negative						
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum		Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum
Total	35	19	8	10	7	0	Total	4	4	7	7	3	3
Percentage	79.5	43.1	18.1	22.7	15.9	0	Percentage	6.8	6.8	12.0	12.0	5.1	5.1

Positive Cases	44		Negative Cases	58	
Changes in uniformity of coating present in	40	90.9%	Changes in uniformity of coating present in	13	22.4%
Uniform coating present in	4	9.0%	Uniform coating present in	45	77.5%

tuberculosis is so often only confined to the ileocecal area.

In Table VII, an analysis is made of relation of pain and tenderness to location. The findings speak for themselves. It is only pertinent to add that each patient was also examined for the presence of intercostal neuralgia by the method advocated by Carnett in order to study them separately later. Worth mentioning also is the fact that when a roentgenologist palpates with a kid gloved hand under the roentgenoscopic screen, he can more accurately determine the localization and relationship of pain and tenderness to the affected segment or organ than the unaided clinician.

The finding of incompetency of the ileocecal valve has been of no particular aid in the diagnosis of ileocecal tuberculosis, as shown in Table VI. This was

TABLE VI

Incompetency of Ileocecal Valve

	Incompetent		Competent		Incompetent		Competent
	Immediate	Delayed			Immediate	Delayed	
Total	25	8	11	Total	25	10	23
Percentage	56.8	18.1	25.0	Percentage	43.1	17.2	39.8

Fig. 2*d*. Same patient nine hours after ingested meal. Considerable gastric residue still present. The head of the column reached the rectum, the patient having had a bowel movement before the examination. Residue fairly uniform in the proximal transverse colon; terminal ileum and right ascending colon practically completely evacuated.

Fig. 2*e*. Same patient, barium enema. Marked contraction of the cecum and proximal ceco-colon with irregularity of the contour and margins partly obliterated by redundancies of the proximal transverse colon and sigmoid.

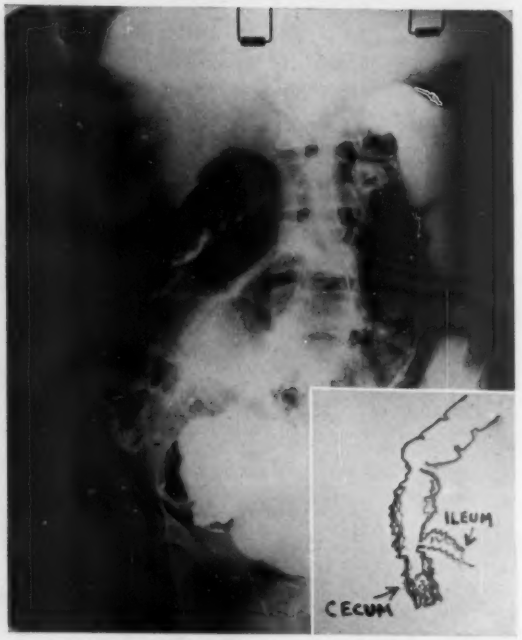

Fig. 2*f*. Same patient. Double contrast enema. Shows the amount of contraction and irregularity involving the terminal ileum, cecum and ceco-colon. Changes in the distribution of the mucosal barium coating in the involved areas and hyperplastic tissue are distinctly visible in the lumen of the ascending colon near the hepatic flexure. Compare the uniformity of the barium coating of the margins of the involved ascending colon with the uninvolved descending colon.

somewhat surprising to us because before actually making this analysis, its occurrence seemed more frequent in positive than in negative cases.

Thus far, this report has been limited to the analysis of signs as they occur in *early* cases of ileocecal tuberculosis, the group with which we should be most concerned if successful therapeusis is to be obtained. In the moderately and far-advanced cases, all methods with the mouth meal or either of the enema studies reveal characteristic changes that have already been well elaborated. It might be added, however, that the double contrast enema roentgenograms often reveal additional intraluminal pathological changes not visibly accessible in the opaque barium column of the single contrast enema or mouth meal roentgenograms. These supplementary changes

TABLE VII

PAIN AND TENDERNESS ALONG COURSE OF COLON

Relation of Pain and Tenderness to Location

	Single Contrast Enema				Double Contrast Enema			
	Positive		Negative		Positive		Negative	
	Total	Percentage	Total	Percentage	Total	Percentage	Total	Percentage
Cecum	23	52.2	5	8.6	21	47.7	3	5.1
Ceco-colon	14	31.8	2	3.4	11	25.0	1	1.7
Transverse	0	0	0	0	1	2.2	0	0
Descending	0	0	2	3.4	0	0	1	1.7
Sigmoid	0	0	0	0	0	0	0	0
Rectum	0	0	0	0	0	0	0	0

Relation of Location to Pain and Tenderness

	Single Contrast Enema												Double Contrast Enema											
	Positive						Negative						Positive						Negative					
	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum	Cecum	Ceco-colon	Transverse	Descending	Sigmoid	Rectum
Total	23	14	0	0	0	0	5	2	0	2	0	0	21	11	1	0	0	0	3	1	0	1	0	0
Percentage	52.2	31.8	0	0	0	0	8.6	3.4	0	3.4	0	0	47.7	25.0	2.2	0	0	0	5.1	1.7	0	1.7	0	0

Positive Cases	44		Negative Cases	58		
Cases where pain or tenderness was present	35	79.5%	Cases where pain or tenderness was present	9	15.5%	
Cases where pain or tenderness was absent	9	20.4%	Cases where pain or tenderness was absent	49	84.4%	
Positive Cases	44		Negative Cases	58		
Cases where pain or or tenderness was present	33	75.0%	Cases where pain or tenderness was present	5	8.6%	
Cases where pain or or tenderness was absent	11	25.0%	Cases where pain or tenderness or was absent	53	91.3%	

have already been dealt with in the preliminary report.

SUMMARY

The studies with the single and double contrast enema afford an easier, quicker, less expensive and more reliable method for the diagnosis of early ileocecal tuberculosis than the mouth meal method. This conclusion is soundly based on our studies at Eagleville Sanatorium. An analysis of 102 consecutive cases of pulmonary tuberculosis with tubercle bacilli in the sputum is made in this report, which shows the relation of the various roentgen signs, their frequency of occurrence and their location in 44 positively and 58 negatively diagnosed cases of ileocecal tuberculosis. Because the enema studies reveal these signs with greater diagnostic accuracy than the mouth meal studies in these early cases, its routine use is found more practical and satisfactory. The mouth meal method was found to have its greatest usefulness as a supplementary examination in those cases with intestinal symptoms and negative enema findings where lesions were confined to the jejunum and ileum.

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THE APPENDIX, MORPHOLOGICALLY CONSIDERED*

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THE physiological and anatomical characteristics of the appendix offer definite obstacles to complete roentgen study. The uncertainty of obtaining within a reasonable time a satisfactory roentgenogram of the appendix unobscured by adjacent viscera has markedly limited its use, particularly in the acute and subacute pathological states.

Roentgenologists have reported successful filling of the appendix in 70–90 per cent of the non-acute cases. In a series of routine gastrointestinal studies of 141 consecutive (non-operated) patients we were able to visualize the appendix at the six, twenty-four, forty-eight, or seventy-two hour interval in 72 per cent. By further study, that is, after the barium clysma, after evacuation of, or six or twenty-four hours after the clysma, or after sediment mixture ingestion following catharsis, this percentage was increased to 90.

FIG. 1. Case 1. Non-pathological appendix at 28½ hour interval.

While this frequency of appendicial visualization may suffice, the method proved decidedly impractical, necessitating in the exceptional case nine or ten roentgenoscopic observations with considerable manipulation and consuming more than a week in which to complete the examination. At the outset, therefore, we are faced with the chief obstacle to thorough appendicial investigation and until more suitable means can be devised further progress seems unlikely.

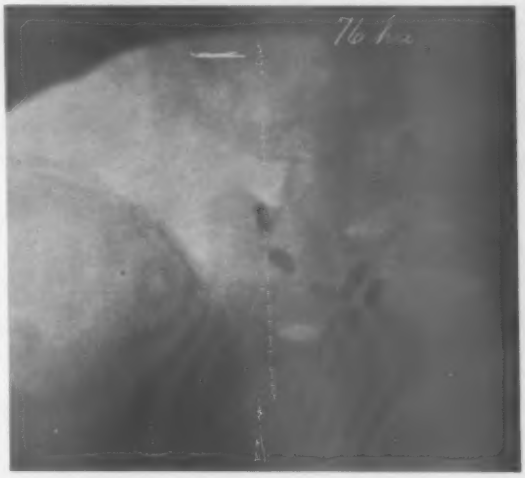

FIG. 2. Case 1. Non-pathological appendix at 76 hours.

Among the common causes of non-filling of the appendix with the opaque mixture may be considered:

1. Physiological non-visualization—
   Appendix having been filled with opaque ingesta and evacuated prior to observation.
2. Obstructed lumen—
   A. Normal appendicial feces or concretions.
   B. Spasm at ostium or possibly of shaft.
   C. Pathological obliteration of lumen.

Roentgen evidence of appendicial pathology. At present the most generally accepted roentgen evidence of inflam-

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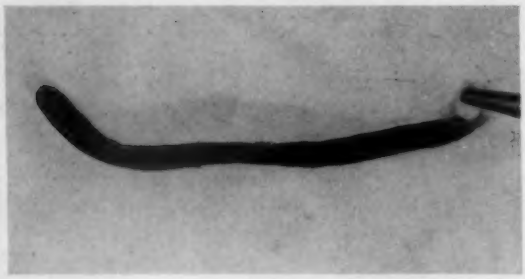

Fig. 3. Case I. Non-pathological appendix after injection, post operation.

mation is unquestionable tenderness or referred pain elicited on palpation over the appendix in its assumed and in its misplaced position during roentgenoscopic manipulation.

Reflex phenomena, while not characteristic of, may be associated with pathology of the appendix; extrinsic spasm may be found along the alimentary tract particularly at the pylorus, duodenal, duodenojejunal, ileocecal and cecocolic areas.

The position and length of the appendix may be readily determined by direct observation. Undoubted fixation of the shaft or tip of the appendix or persistently deformed shape indicates involvement of its serosa by adhesions. Interval examinations until complete evacuation of its contents provide data concerning motility. In brief, the roentgen examination to date has been limited, more or less, to the indirect evidence of disease. Consequently studies of the appendical lumen have recently been instituted to ascertain the characteristic filling defects, if any, of the various pathological states involving this organ. These examinations were made of the filled appendix in vivo and after removal at operation or post mortem.

FIG. 4. Case II. Atrophic appendix.

The normal appendix. The shadow of the normal lumen is uniform in density and width from its ostium to tip, with the following exceptions.

1. Presence of fecal contents unmixed with opaque material.
2. Inspissated opaque ingesta which has become fragmented apparently by longitudinal muscular relaxation.
3. Partial-evacuation—proximal portion first evacuated.
4. Intrinsic muscular contraction.

The pathological appendix. Certain abnormal changes of the wall of the appendix produce definite deformities of the lumen which roentgenographically appear characteristic of such pathology. Edema and infiltration of the mucosa and submucosa produce slight irregularities of the wall contour varying with the degree of pathology. In the more virulent infection destruction of the appendicial wall may be distinguished by the presence of barium in the deeper layers.

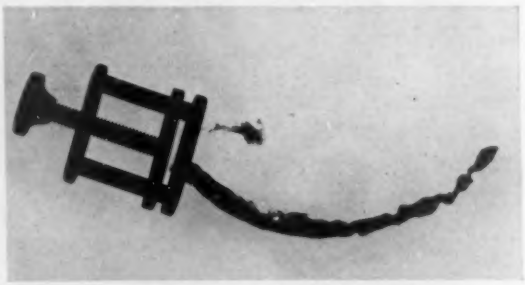

FIG. 5. Case III. Atrophic appendix with fibroblastic changes.

At times there may be observed small hemispherical indentures of the lumen which suggest spasm of the circular muscular coat.

In certain acute stages, portions of the lumen may be completely occluded by pathological changes within the wall and the retention of debris and inflammatory

products. Occlusion of the lumen also occurs, though more completely in chronic obliterating appendicitis in which non-visualization of the appendix occurs. Strictures of the lumen of more or less regular outline appear to result from fibrosis of the wall with contracture.

Recognition of a minor degree of cellular infiltration, on which a questionable pathological report of chronic appendicitis may be made, is impossible by study of the luminal shadow; such changes, however, are microscopical and whether they may be considered symptom-producing is controversial. The following cases demonstrate certain of the characteristic luminal shadows noted after injection:

Case I. G. R., female, aged sixteen. Complaint, vague pain throughout right lower

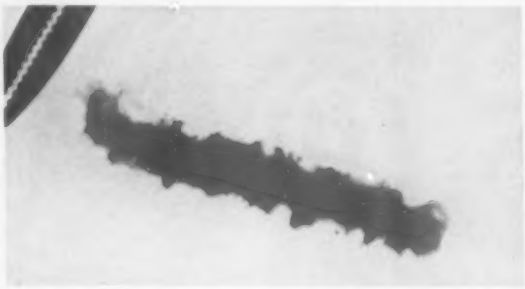

Fig. 6. Case IV. Acute exudative appendicitis.

quadrant; roentgenoscopically no evidence of appendicial pathology. The appendix is filled twenty-eight hours after ingestion of opaque meal; lumen uniformly filled except for small area proximal to tip; lumen of regular contour (Fig. 1). At seventy-six hours barium column fragmented; change of shape and position of appendix (Fig. 2). Figure 3—after surgical removal; appendix now contains freshly injected opaque mixture in addition to that which has been retained from barium meal; note regularity of contour of lumen. Pathological report—no evidence of inflammatory changes.

Case II. M. C., female, aged fifty-six. Chief complaint, pain in the back. Onset of symptoms about five months ago with prolapse of the uterus. Inability to control urinary bladder. Appendectomy incidental to gynecological operation. No appendical history. Roentgen-

Fig. 7. Case V. Acute necrosing appendicitis.

ogram of the appendix after filling of the specimen with barium reveals an abnormally narrow lumen of practically regular contour throughout its entire course (Fig. 4). Pathological report: Mucosa destroyed; slight adiposis; marked atrophy of all coats.

Case III. S. C., female, aged twenty-three; white, houseworker. Pains in the lower abdomen on and off for the past three years preceded by a copious vaginal discharge which has lately improved under treatment. Five weeks ago patient noticed a creamy yellow discharge and a week later pain again began to develop in the lower abdomen, growing in intensity as time elapsed. Diagnosis: bilateral salpingo-oophoritis. Appendectomy incidental to operation. Roentgenogram (Fig. 5) discloses irregular defect along one wall of the proximal half of the appendix (detritus); the

Fig. 8. Case VI. Acute exudative appendicitis of distal shaft; lumen occluded by concretions.

FIG. 9. Case VII.

distal end presents well defined indentures of the lumen. Pathological report: chronic appendicitis. Section (*a*) of the proximal half shows fecal detritus; (*b*) of the distal end shows atrophic changes on one side of the lumen and fibroblastic hyperplasia opposite same which encroaches on the lumen.

CASE IV. E.B., aged thirty-seven, housewife. Chief complaint, pains in the right lower quadrant. No previous attacks. Present attack—acute onset two days prior to operation. White blood cells, 9,000; polymorphonuclears, 68 per cent. Roentgenogram (Fig.6) after injection of barium post-appendectomy reveals: a short appendix with multiple superficial irregularities and deeper hemispherical indentures. Pathological diagnosis: exudative appendicitis; marked congestion and edema with prominence of goblet cells in the mucosa and submucosa; invasion of all the coats by polymorphonuclear cells.

CASE V. D.I., aged twenty-two. History of acute pain in the right lower quadrant and vomiting. Roentgenogram (Fig. 7) of the specimen post-appendectomy reveals: a 4½ inch long appendix, two-thirds of which can be filled with barium. Barium column is of non-uniform density, several small areas of extraluminal filling (necrosis); lumen of distal third is occluded probably by inflammatory products and infiltration of walls. Pathological report: acute necrosing appendicitis. Areas of necrosis of the mucosa and replacement by purulent exudate. Mucosa shows more destruction in the middle section than in the proximal end. Pus and free blood are in the lumen.

FIG. 10. Case VII. Postoperative specimens in Ringer's solution.

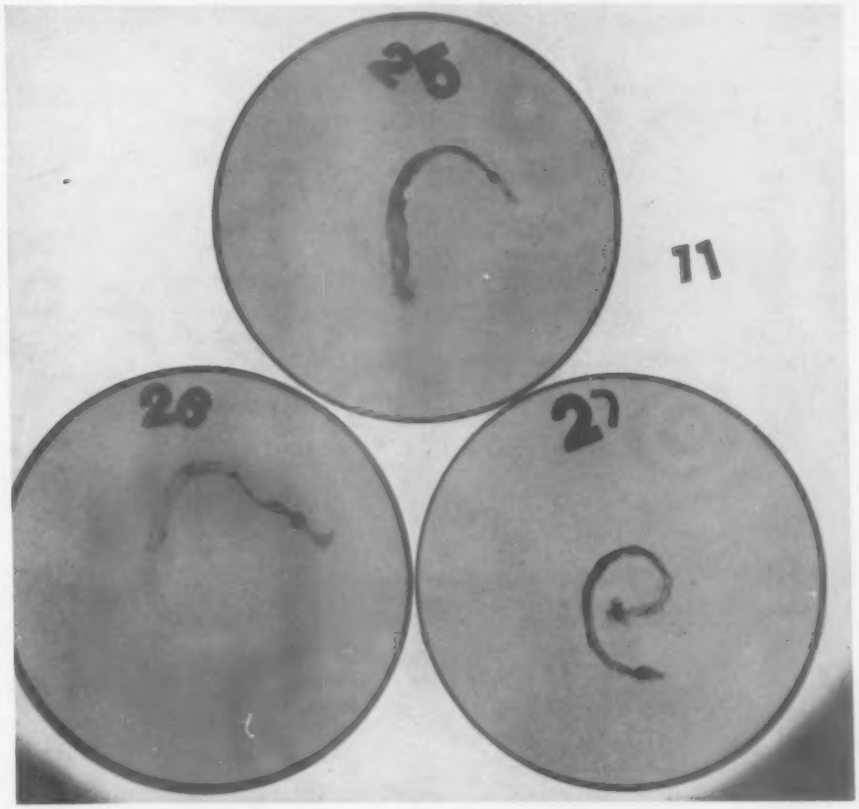

Fig. 11. Case vii. Same specimens as shown in Figure 10 after addition of pilocarpine.

Other coats show marked vascular reaction and infiltration. Distal portion shows no lumen. No lymphoid follicles are evident and the entire wall of the appendix here is likewise infilrated with pus cells.

Case vi. M.P., male, aged forty. Very acute attack, vomiting and pain in the right lower quadrant. White blood cells, 20,600; polymorphonuclears, 79 per cent. Figure 8 shows specimen of the appendix 5.8 cm. long; well filled in its proximal portion, showing wide lumen with large central defect (concretions) in the mid-portion occluding the lumen. Pathological report: acute exudative appendicitis. Longitudinal section of the appendix: Marked edema of the mucosa and submucosa and atrophy of the muscularis in the distal portion; there is marked degeneration of the mucosa and atrophy of the muscularis in the mid-portion, corresponding to site of concretions.

Case vii. B.R., aged thirty-four. Appendectomy incidental to operation for cystic ovary. Roentgenogram (Fig. 9) reveals a well-filled lumen through the entire appendix with numerous extraluminal collections of opaque mixture and several dense bands extending transversely across the shaft. A satisfactory explanation has not yet been offered for this unusual finding. Pathologically, a slight degree of fibroadiposis only was noted; however, a transverse section only was studied. Since this occurrence longitudinal sections of the entire appendix have been made.

To study the activity of the appendix, specimens were partially filled and treated after the method of Rössle. Appendices in Ringer's solution (Fig. 10); same specimens (Fig. 11) within one minute after the addition of 1-1000 pilocarpine solution. Note marked change in shape; in the well-filled organs the contents of the proximal shaft are evacuated during this activity.

In concluding, it may be stated that preliminary study of the luminal shadows of normal and diseased appendices indicates

that the deformities produced seem characteristic of certain underlying pathological states. While satisfactory visualization of the appendix, particularly in the acute and subacute inflammatory stages, appears at this time quite hopeless, the valuable information to be gained justifies attempts to surmount the obstacles which thus far have impeded complete roentgenological investigation of this organ.

Acknowledgment is made of the kind assistance of the pathologists, Drs. William Hala and Berthold Comeau.

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SEPARATION OF THE SYMPHYSIS PUBIS

WITH REPORT OF FIVE CASES

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THIS paper is presented to direct further attention to a condition which has in the past received little consideration, probably because of its comparatively infrequent occurrence and its even less frequent recognition. The incapacity and impairment of locomotion caused by separation of the pubic bones with its associated sacroiliac injury are often sufficiently marked to merit greater interest and more careful study.

Separation of the symphysis pubis probably occurs more frequently than at least the older statistics would indicate, which will, no doubt, be demonstrated by more careful examination of patients, particularly in those following difficult or complicated labor and especially by more frequent use of the roentgen ray.

HISTORY

The ancients taught that the pelvic joints always softened during pregnancy and opened during labor, so that the fetus could readily pass through. They also ascribed difficult labor to too great rigidity of these joints. Later, the opposite condition was believed to be normal, and those in whom relaxation of the pelvic joints occurred were considered morbid.

De Lee[6] believed the ancients must have reasoned from analogy, having observed the softening of the joints in cows and other animals; the "sinking of the rump" and the difficulty of locomotion of the cow show the veterinarian that the animal is near term. In guinea pigs the pelvic ligaments soften and allow separation of the pubic bones as much as one inch, and the legs may even be laid flat alongside the animal; after labor, the joints again become normal.

ETIOLOGY

Separation of the symphysis pubis may be divided into two general classes: (*a*) those complicating childbirth, comprising the great majority, and (*b*) severe trauma, the result of train and automobile accidents, falls, etc., which are often complicated by serious visceral injuries and have a high mortality. This group is relatively small, and therefore less important.

Sparrow[19] reports a case resulting from the wheel of an automobile resting upon the anterior superior iliac spines, causing a separation of 9 cm.

Schaanning[18] reports a case in a pregnant woman near term, who slipped and fell on the street.

Willan[21] reports 2 cases and Buckley[4] one case, resulting from falls from horses.

Koven[14] contributes another due to an automobile accident.

The earlier writers would lead us to believe that even the first group or those occurring during parturition are extremely rare; thus Kehrer[13] was able to collect only 100 cases from the literature up to 1915.

Tuley[20] reports one case in 30,000 deliveries; Morgan[17] 4 in 80,000; Kayser[12] 3 in 94,000 and Hirst and Wachs[10] reported the occurrence of this complication 3 times in 94,149 labors.

More recently (1929) Wishner and Mayer[22] of the Orthopedic Department of the Hospital for Joint and Bone Diseases, New York, have observed 5 cases in 1 year.

Five cases have come under our observation since 1927 at the Misericordia Hospital, one in a man, the result of an automobile accident, 2 following difficult forceps deliveries, one following spontaneous delivery, and one associated with a congenital dislocation of the left hip.

This separation was present on films made previous to any manipulation for reduction of the dislocated hip and is therefore definitely congenital and not as we at first thought due to the efforts at attempted reduction.

De Lee[7] gives as contributing causes softening and relaxation of the capsule, caries, rachitis, congenital weakness of the ligaments, all of which have been found in such cases when even the distention of the pelvis during spontaneous delivery may cause the joint to give way. Contracted pelves, especially the justo minor and funnel varieties, because the expulsion force acts in the narrow transverse diameter predisposes to separation of the pubic bones. A large child or especially broad shoulders may act in the same way.

ANATOMY AND PHYSIOLOGY

The articulation between the pubic bones is an amphiarthrodial joint formed by the junction of their two articular surfaces. These bones are held together by four strong ligaments, anterior, posterior, superior and inferior (arcuate).

It is a debatable question whether or not slight motion exists in the joint normally. It is generally accepted, however, that during pregnancy there is a definite relaxation of softening of all the pelvic ligaments which may permit of a separation even before delivery.

Beach[2] reports a case in which this separation amounted to 7.5 cm. One case observed by us in 1927 had separation of 6 cm., as measured from a film made on the Potter-Bucky diaphragm. This was the result of a difficult forceps delivery.

MECHANICS OF SEPARATION

The cause of separation is no doubt due to the pressure effect of the advancing head on the pelvic ring, which gives at its weakest point. Frequently, forceps are a potent factor. Exceptionally during delivery, a distinct crack has been heard, suggesting an acute tear (MacPherson).

Lynch[15] believes that there is a stretching of the ligaments rather than a tear.

Goldthwait and Osgood[9] in 1905 reviewed the literature thoroughly, but were unable to find any allusion to such affections of the pelvic joints apart from pregnancy. They later were convinced that certain cases occur, in the absence of pregnancy, in connection with menstruation and finally they successfully applied the same considerations to explain certain cases of low back and leg pain and disability, occurring both in men and in women.

With the object of studying the sacroiliac joints, Chamberlain[5] developed a technique for detecting and measuring the degree of movements of the pubic bones, which occurs with alteration of weight bearing from one leg to the other. First, normal individuals were studied, and he found movement at the pubes amounting to from 0 to 0.5 mm. in the male, and from 0 to 1.5 mm. in the non-pregnant female, and that movement of 2 mm. or more invariably caused symptoms.

When the pubic bones separate, there is necessarily a separation, at least in the anterior portion of one or both sacroiliac joints. This has been observed by myself and has been well worked out by Wishner and Mayer who studied the mechanism on a pelvis removed from a female cadaver with all the ligaments intact. After the pubic ring was cut through at the symphysis, the pubic bones were pried apart a distance of 4 cm. As this was being done, the anterior sacroiliac ligaments were seen to give way and the roentgenogram showed the joints gaped open about ¼ inch. Separation of from 0.3 to 0.9 cm. are considered by various observers normal following delivery.

CLINICAL PICTURE AND DIAGNOSIS

Most often following an unusually difficult labor, especially when high forceps are used, following delivery, pain is felt in the pubic region and lower back which radiates down the thighs. Difficulty in moving the

legs, even when in bed, is experienced. On getting up, the patients have greater pain and find walking very difficult. They may feel a definite separation and movement of the pubic bones with each step.

The objective signs are usually quite characteristic. The gait is a peculiar waddle, due to the instability of the pubic arch, and the malalinement of the hip joints to the body, and is frequently so typical that a diagnosis can be made from this alone. There is definite tenderness over the symphysis and one or more fingers may be inserted between the pubic bones. There may be tenderness over one or both sacroiliac joints. Motion may be demonstrated at the pubes, by manipulation of the legs and thighs.

The roentgenogram either makes or confirms the diagnosis. The associated separation of the sacroiliac joints is not always detectable on the film.

The technique for the roentgen examination, especially the relation of the pubic bones to the film, is of the utmost importance, if the measurements of the amount of separation are to be accurate. For example, on one of our patients, a film was made on a Potter-Bucky diaphragm in the anteroposterior position, and the separation measured 6 cm. (Fig. 2*a*). Another film was made at the same time, with the patient in the posteroanterior position, when the amount of separation measured only 4.75 cm. (Fig. 2*b*). For practical purposes, however, most valuable diagnostic information is obtained from films made in the anteroposterior direction, especially since most pelvic studies are made in this position, it being only necessary to bear in mind that there is a considerable exaggeration of the separation due to the position and also a slight exaggeration due to the Potter-Bucky diaphragm. By placing the cassette directly in contact with the symphysis, the patient lying on her abdomen, with a focal tube distance of 36 inches or more, very exact measurements may be obtained. Frequently, however, the condition of the patient in regard to pain and stage of puerperium render this last procedure impractical.

TREATMENT

Many methods have been suggested for treatment of this condition.

Boorstein[3] reports 6 cases treated with adhesive plaster and belts with excellent results.

Allen[1] inserted a Lane plate. This did not hold and it had to be removed later. Through two small skin incisions, he then inserted two nails into the iliac spines allowing them to protrude above the skin. Strong wire was bound around these nails. A cast was applied, and after eight weeks the patient was able to walk.

McNamara[16] closed the symphysis by passing No. 4 silver wire through the obturator foramen. This gave good results.

Boorstein and others recommend that the patient be placed on a Bradford frame to facilitate nursing care. A pillow is placed under the knees to relieve the drag of the extremities upon the pelvis, the knees being loosely bound together for the first week. A broad strap of adhesive plaster is applied to the pelvis. The ends are brought around in front and doubled back to provide a firm support for the insertion of a lacing of bandage or other material which is used to tie them together tightly in front of the pubis. Later, a webbing belt is used, encircling the body just above the level of the trochanters, and drawn firmly together in front by appropriate straps and buckles. If the gaping of the symphysis is very marked, a broad canvas sling or hammock should be passed under the pelvis and lower back, and the ends secured to the overhead beams of a Balkan frame. The pressure of the sling on the side of the pelvis from the patient's weight exerts a strong compression force on the bones which tends to push them together.

Holderman[11] uses a large, heavy leather belt sufficiently long to circle the pelvis, 7 cm. in width, and 0.3 cm. in thickness. On its inner surface, it is lined with fetl, 0.5

cm. thick, and the felt is sufficiently wide to extend 0.75 cm. beyond the edge of the leather.

Complete recovery is variously estimated from a few weeks to six months, depending, at least to a large degree, upon the amount of separation present, and the promptness with which the treatment is instituted.

FIG. 1. Case I. Showing separation of the pubic bones of 3 cm. and also an increase in width of the sacroiliac joints. The left pubic bone is displaced upward 4 mm. This case resulted from a difficult forceps delivery.

CASE REPORTS

CASE I. Mrs. J. A., aged thirty-one, primipara. Born in Italy. Housewife by occupation. Was admitted to the Misericordia Hospital, October 7, 1927. Menses began at the age of thirteen, at 28-day intervals and lasted usually about five days. Her last period occurred in January, 1927. The only symptoms thereafter were early nausea and vomiting. Physical examination on admission revealed a young, healthy adult Italian, showing pregnancy approximately at term, the fetus in the L. O. A. position, vertex presenting. Pains began October 9, 1927, and were terminated twelve hours and seven minutes later after the application of forceps. The cervix and perineal floor were deeply lacerated. Excessive bleeding continued for several hours, which was controlled by packing and abdominal binder was applied. The patient complained bitterly of pain in the lower abdomen and lower back.

A roentgen examination was made October 14, which showed separation of the symphysis pubis of 3 cm., and an increase in the width of the sacroiliac joints. There was upward displacement of the left pubic bone 4 mm. (Fig. 1). The pelvis was tightly encircled with adhesive plaster, which was allowed to remain in place until the patient was discharged, October 29, 1927. Walking caused only slight pain in the symphysis and sacroiliac region.

CASE II. Mrs. M. H., aged twenty-five, white, housewife, referred to the Roentgen Department because of difficulty in walking and pain in the pubic region and lower back. Her difficulties dated back one year, when she was delivered of a full term baby by forceps at home. This was her first pregnancy.

The roentgen examination showed separation of the pubic bones of 6 cm., as measured from a Potter-Bucky film, made in the anteroposterior direction (Fig. 2*a*), and measuring 4.75 cm. on a film made in the posteroanterior position (Fig. 2*b*). There was shown also very definite and moderately marked separation of both the sacroiliac joints. At the time of this examination, the patient was four months pregnant. Five months later, she delivered herself spontaneously of a full term baby. Previous to this second pregnancy, she complained of only slight pain in the lower abdomen and back, which became aggravated after conception. Following delivery the pains again improved and the waddling gait was the principal complaint.

FIG. 2*a* Case II. The pubic bones are separated 6 cm. as measured from a film made on the Potter-Bucky diaphragm with the patient in the supine position. The sacroiliac joints also show definite subluxation, following difficult forceps delivery.

CASE III. Mrs. A. D., Italian, aged thirty-one, admitted to the Misericordia Hospital, September 13, 1927. Discharged after a normal spontaneous delivery, September 28, 1927.

In 1924, this patient had had a dead fetus removed at the fifth month. In 1925, she delivered herself spontaneously of a normal full term baby. Pains began at 11 A.M. on September 13, 1927. The membranes ruptured at 10:20 P.M. September 14. A normal, male baby was born spontaneously at 11:50 P.M. Duration of labor was 25 hours. She sustained a superficial laceration of the perineum, which required only one suture.

A roentgen examination was requested because of persistent pain in the symphysis, and revealed separation of the pubic bone 1 cm.,

Fig. 2*b*. Case II. This film was made with the patient in the prone position, and the separation measured only 4.75 cm.

and upward displacement of the left pubic bone 3 mm. (Fig. 3). Slight pain produced by walking was present on discharge.

Case IV. Male, aged sixteen, was referred to the Misericordia Hospital Roentgen Department, complaining of pain in the bladder region, which pain was greatly aggravated by walking. Three days previously, he was squeezed by an automobile against a garage door. The roentgen examination showed separation at the symphysis of 1 cm. There were no fractures present, nor was there any demonstrable disturbance in the sacroiliac joints (Fig. 4). This patient was treated at home, with a pelvic girdle of adhesive

Fig. 3. Case III. Following a spontaneous delivery which lasted twenty-five hours. The pubic bones are separated 1 cm. and the left pubic bone is displaced upward 3 mm.

plaster tightly encircling the pelvis to below the level of the trochanters. After two weeks in bed, the patient was allowed up, and was completely free from symptoms.

Case V. B. T., female, aged three. Referred to us March 17, 1930, with a diagnosis of congenital dislocation of the left hip.

The roentgen examination showed complete dislocation of the left femoral head, with marked internal rotation of the shaft of the femur. The left acetabulum is quite shallow and its roof is poorly developed. The remaining bones of the pelvis, including the femur, are

Fig. 4. Case IV. This patient was squeezed against a garage door by an automobile, resulting in a separation at the symphysis of 1 cm., with no evidence of fracture.

FIG. 5. Case v. Shows a congenital separation of the symphysis pubis associated with congenital dislocation of the left hip. Films were made of the pelvis previous to any manipulation of the left femur for reduction; this separation is therefore definitely congenital.

generally slightly less well developed on the left than on the right side. The pubic bones are separated to the extent of 4 cm., and the sacroiliac joints seem to be abnormally wide. The original films in this case were made before reduction of the dislocated hip was attempted. The separation at the symphysis is therefore undoubtedly congenital in origin.

Following reduction of the left hip by the closed method, a cast was applied with both thighs in extreme abduction.

The roentgen examination showed that the reduction of the dislocated hip was successful, and that there was no change in the separated pubic bones. A final film was made January 3, 1931, which showed partial dislocation of the left femoral head and the pubic separation identical with that shown by the original films (Fig. 5).

This last case is of special interest because in reviewing the literature only one other somewhat similar case was found. Duhem and Marfan,[8] in 1927, reported a case of congenital dislocation of the sacroiliac joints with separation of the pubis. This indicates that congenital separation of the pubic bones must be extremely rare.

CONCLUSIONS

1. Separation of the symphysis pubis following labor occurs more frequently than was formerly believed and is quite rare from all other causes.

2. Very difficult labors and, at times, improper forceps deliveries are the greatest etiological factors in the production of separation of the pubic bones.

3. Roentgen examinations, especially in primiparas, should be made more frequently to discover any disproportion between the presenting part and the pelvic cavity.

4. Separation of as much as 0.9 cm., during or following pregnancy, is considered normal by most observers.

5. Good functional results are usually obtained in the lesser degree separations and marked improvement in practically all cases.

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GASTROHEPATIC FISTULA*

CASE REPORT

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SINCE gastrohepatic fistulae are relatively rare, this case seems sufficiently important to warrant reporting. These fistulae are merely pathological curiosities quite impossible to diagnose and are only discovered post mortem.

Gastrohepatic fistulae are usually malignancies which by irritation cause inflammation, resulting in plastic peritonitis with adhesions to the surrounding structures. The thick indurated wall of the carcinomatous stomach produces constant irritation to the liver and causes an ulcer which develops into fistulous communication by ulceration.

CASE REPORT

A. W. D., male, colored; occupation, farmer, was admitted to Edward Hines Jr. Hospital for treatment of tumor of the abdomen.

FIG. 1. Roentgenogram shows an island of barium in the liver.

Family History. Father dead; cause of death appendectomy. Mother living and in poor health. One brother living and well. Two sisters living and well. No record of tuberculosis, cancer or insanity in the family. Patient is married and has one child.

Personal History. Had measles; does not recall having had any other childhood diseases. Was hospitalized during service for stomach condition. Denies use of drugs, alcohol or tobacco. No operations.

Chief Complaints. Pain in abdomen, worse on left side. Had noticed excessive gas in stomach after eating. During first part of 1930 noticed shortness of breath. Tires easily. For the past ten months has had pain in left side of abdomen. Swelling of the feet and legs. Loss of weight. Has been unable to work on account of extreme weakness.

Physical Examination. Poorly developed male; appears chronically ill. Skin, eyes, mouth, chest, heart and pupils negative. A mass was felt in the pit below the border of the ribs on the left side, three fingers breadth below and extending up under the costal margin, somewhat tender.

Special Surgical Consultation. Patient presented a history of loss of weight, having lost 20 pounds since 1930. He appeared cachectic and had a large solid mass immediately over the stomach.

Laboratory Findings. Urinalysis negative. Blood Wassermann and Kahn negative. Fractional stomach contents: Occult blood. Feces brown in color; no parasites or ova found; consistency mushy. Occult blood positive. Protozoa none. Mucus none.

Roentgen Examination of Chest and Heart. Stereoscopic roentgen examination of the chest revealed evidence of an old fibrous adhesion at both bases. The bony framework of the thoracic cage exhibited no anatomical or pathological

* Published by authority of J. G. Donnelly, Acting Medical Director, United States Veterans Administration.

variation from the normal. Cardiac image at 6-foot distance was of normal size, shape and position, revealing no bulging, displacement or other roentgen evidence of organic pathology. Lung fields were radiant throughout all lobes, displaying no demonstrable evidence of intrapulmonary pathology.

Roentgen Examination of Gastrointestinal Tract. Roentgenoscopic examination revealed the opaque media passing through the esophagus without undue hesitation. Stomach showed a large filling defect involving the pars media and lesser curvature side of the stomach; walls were inflexible. No peristaltic waves were seen. The duodenal cap was not visualized and there appeared to be considerable obstruction at the pylorus.

Roentgenographic examination confirmed the roentgenoscopic findings, showing on the immediate films a large filling defect of the pars media. An island of barium was in the region of the pars media at forty-eight hours (Fig. 1). Gallbladder was not visualized.

Autopsy. (Performed by Dr. W. L. McNamara, assistant pathologist.) Body was that of a fairly well-developed, markedly emaciated male. Skin was icteric, as were the sclerae and mucous membranes. Abdomen was distended. There was a patent gastroenterostomy. No glandular enlargement. Pupils equal.

Peritoneal Cavity. No adhesions to the chest plate. Both lungs inflated; about 500 c.c. of fluid at each base. Pericardial sac occupied a normal position and contained 50 c.c. of clear fluid. Pericardium smooth.

Heart. Heart weighed 320 grams; muscle pale and very poor in consistency. Aortic and mitral valves held water. No atheromatous change in the aorta. Coronary vessels clear.

Liver. Liver was enormous; surface nodular, with large grayish-white tumor metastases; left lobe was enlarged to a greater size than the right. Stomach was rotated so that the anterior surface was in contact with the under surface of the left lobe of the liver. A large fungating

Fig. 2. Photograph of autopsy specimen, showing carcinoma of the stomach, involvement of the liver and a gastrohepatic fistula.

tumor mass which measured 6 cm. in diameter involved the anterior wall of the stomach near the greater curvature. This was in direct contact with the under surface of the liver and dense adhesions bound the two. Tumor mass had invaded the liver diffusely. There was much digestion of tumor tissue and the digested cavity was about the size of a large grapefruit (Fig. 2). A small area had broken through and was covered with omentum.

Gallbladder. Gallbladder was distended due to pressure on the cystic duct. Wall was thin and there were no stones.

Anatomical Diagnosis. Adenocarcinoma of stomach with extension to the liver.

Roentgen Diagnosis. Carcinoma of stomach.

LATE RESULTS FROM COMBINED ELECTRO-COAGULATION AND IRRADIATION OF SUPERFICIAL CANCERS

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THE well-deserved popularity of electrocoagulation in America is due to the splendid pioneer work of Clark,[3] Pfahler,[9] Wyeth,[11] and a few others. My own work with this form of treatment was begun some ten years ago, and for the past six years has been the method of choice. Electrocoagulation presents certain great ad-advantages: (1) Examination of tissue is possible in all cases; (2) the removal of the growth is prompt; (3) it can be used in growths that have resisted irradiation, or that are situated in scar tissue or cartilage; (4) it can be used in areas that are difficult of access to either the knife or irradiation; (5) the permanent results are superior to those obtained by any other method. By the proper use of local anesthesia the operative procedures are practically painless; there is almost no after pain and the scarring is usually very slight as the wound granulates up from the bottom. The chief disadvantage is that the wound heals slowly; five weeks in the case of small growths, and seven to eight weeks in large growths being the usual time. During this period social activities may require a simple dressing.

The technique employed has been the usual one in all details; all operations have been done under a local anesthetic; the growth circled with the cutting current and tissue removed for examination, then deep coagulation, and lastly the thorough undercutting of the skin in all directions. The roentgen or radium treatments were given as soon as the wound was healed, and consisted of 2½ to 4 S.E.D. In some instances a second treatment was employed. Radium needles were used externally. In no instance was there irradiation of the draining lymph nodes, although the whole field for an area of at least 1 or 2 inches beyond the edges of the scar was irradiated in all cases of squamous cell cancer.

In this study only the cases which have been personally checked are reported; in other words, they represent consecutive, unselected cases from private practice.

TABLE I

Total cases followed		93
Males		54
Females		39
Squamous cell tumors, patients	12	growths 12
Basal cell tumors, patients	81	growths 87
Patients with multiple growths	6	

In addition there was one man who had 20 basal cell cancers of the eczematoid, or psoriaform, type[6] removed with cure for two years. This tumor should be distinguished from the Bowen type,[2] or Paget's disease,[8] both of which are believed to be intradermal tumors probably springing from glandular structure.[4]

The location of the prickle cell cancers is shown in Table II.

TABLE II

Tongue	1
Lip	7
Nose	1
Cheek	3

The location of the basal cell growths is shown in Table III.

With one exception the squamous cell cancers were of less than one year's duration and none were over an inch in diameter. The exception was in the case of an elderly man who had a growth of nearly 3 inches in diameter situated upon the right cheek and secondary to lupus erythematosus. This patient was well for two years when he died from intercurrent disease.

TABLE III

Scalp	2
Forehead	2
Temples	5
Cheeks	28
Nose and naso-facial folds	24
Ears	6
Lips	1
Inner canthi	2
Outer canthi	3
Eyelids	3
Chin	1
Neck	5
Trunk	2
Hands	2

The size of the basal cell lesions is given in Table IV.

TABLE IV

Under ½ inch	22
½ to 1 inch	54
Over 1 inch	11

The extent of the involvement, or the occurrence in scar tissue, whether produced by trauma, disease, irritation, or operation is shown in Table V.

TABLE V

Bone involvement	1
Cartilage involvement	9
Scar tissue	8

In the course of 150 operations for malignancy there has been only one patient who complained of the scar, and in only one instance was there a serious postoperative complication. In the last mentioned instance a fatal pulmonary embolism developed eight days after the removal of a vulvar neoplasm. A review of the literature reveals the fact that such a complication is exceedingly rare. In 3 instances there has been annoying, and in one other serious, hemorrhage in from three to six days after operation. In all instances operative work had been carried down to the periosteum. It is possible that by using a weaker current, especially toward the conclusion of the operation, the liability of such accidents can be materially lessened.

The results in prickle cell cancer are shown in Table VI.

TABLE VI

Failure	3
Cure, one year	1
Cure, two years	4
Cure, three years or more	4

The results in basal cell cancer are shown in Table VII.

TABLE VII

Failure	2
Cure, one year	7
Cure, two years	18
Cure, three years	23
Cure, four years	15
Cure, five years or more	16

The percentage of cures in prickle cell cancer was 75, and in unselected basal cell growths 97.5. There is an appalling paucity of reports of late results in superficial cancer but the general impression is that the results are better than by any other method. Stevens[10] reports 100 per cent of cures. Andrews[1] gives an excellent bibliography. A comparison of the results obtained in basal cell cancer by endothermy and various other procedures[5] is shown in Table VIII; the figures represent the percentage of cures.

TABLE VIII

	Selected Cases	Unselected Cases
	per cent	per cent
Surgery	93	86
Roentgen rays	93	84
Radium	93	84?
Curette and caustic	90?	?
Endothermy	97.5	97.5

The reports of the results obtained by various therapeutic measures in squamous cell cancer are widely divergent. This is because it is totally unfair to compare the results obtained by an excellent surgeon with those of an inexperienced roentgenologist, and vice versa. Once again the reports of experienced and reliable men would seem to show that combined endothermy and radiotherapy is by far the best method of treatment.

There are many roentgenologists, of whom Martin[7] is a notable example, who

believe in caustic doses of irradiation. There is no doubt that a high percentage of malignancies of all types can be cured by doses of roentgen rays sufficient to cause a local necrosis. To me this does not appear as good a method as endothermy, for which there are several reasons: First, if filtered radiation is used the action upon deeper tissues will probably be marked. Several cases of irreparable damage to teeth and gums have been seen as a result of this method of treatment. Second, there is usually more after-pain as the result thereof. Third, the question arises as to how heavily an area about 1 inch beyond the tumor proper should be irradiated. Certainly this whole area should not be treated with a dose sufficient to cause a necrosis and to treat the edges properly may be a good deal of a problem. Fourth, tissue is not always obtainable for biopsy unless a preliminary curettage be done. Fifth, a knowledge of the extent of the lesion is much better learned from removal of the growth, such as is possible with the cutting knife, than from mere surface inspection and palpation. Sixth, healing is apt to be slower than with endothermy.

A study of failures is always of interest. The first instance was in a squamous cell cancer of the upper lip originating in a chronic radiodermatitis and where the patient positively refused an operation of necessary extent. Local recurrence occurred in one year. A second instance was where a cancer of the cheek had recently received a great amount of irradiation. In the third patient a rapidly growing prickle cell growth, of the most malignant type, on the bridge of the nose remained well for two years, but after ten months there was extension to the cervical lymphatics. The two cases of failure in basal cell cancer were in rather extensive growths of the ear. In the first patient endothermy was not extended into the cartilage, and in the second case the operative field was not sufficiently wide.

CONCLUSIONS

Combined electrocoagulation and irradiation is the most successful method of combating superficial malignancy. Except where the cartilage or bone is deeply invaded it should be successful in all cases of basal cell cancer, and probably in about 75 per cent of the squamous cell growths of lips and skin. Squamous cell growths in areas of radiodermatitis or scar tissue are especially difficult to manage.

The cosmetic results are excellent; the only disadvantages are the slow healing and the tendency to hemorrhage where the periosteum is treated.

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AN EPIPHYSEAL CHART*

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MOST morphological questions in human embryology or gross anatomy may be answered readily by reference to standard atlases and texts, but in the case of the non-adult skeleton much disagreement exists. The situation is explained in part by the fact that it is extremely difficult to obtain children's bodies for dissection. This limitation has not been particularly serious as far as the muscles, blood vessels, etc., are concerned and of course autopsies provide adequate material for the study of visceral development. It has, however, greatly hampered study of the skeleton during an important stage of its development.

For many years roentgen rays have been employed to some extent in anatomical investigation, but for the most part anatomists have ignored the roentgen method or even decried its use.[14] Recently there has been general recognition that the roentgen rays constitute a dependable tool by means of which the anatomist can acquire an unlimited supply of material at any desired age.[6,10,12] However, the addition of roentgenologic data has introduced new problems because such terms as "appearance of ossification" and "fusion of epiphyses" which have definite significance to the anatomist conducting a gross dissection must be reinterpreted if one is to use them in describing skeletal roentgenograms. The point is illustrated by the publications of Stevenson[14] and Paterson.[9] The former reporting on physical examination of dried skeletons gives ages of epiphyseal fusion somewhat greater than most other workers. The latter studying roentgenograms of the living finds epiphyses fused much earlier. Almost certainly these discrepancies represent lack of uniformity in terms and criteria rather than true biological difference. Certain ossification centers may escape detection in conventional roentgenograms but be perfectly obvious at dissection. Paterson has pointed out Cohn's[3] error in the case of the greater tuberosity of the humerus but agrees with him that the lesser tuberosity does not appear as a separate center*.

The chart presented here is designed for ready reference to contemporary information on most of the phases of skeletal development in the human trunk and extremities of the sort likely to come up for consideration during the routine reporting of clinical roentgenograms. As far as possible, it has been constructed on data from published roentgenographic studies of the living[2,6,8,9,12,13] but, in order to accomplish some degree of completeness, it has been necessary to draw as well on the published results of dissecting room studies, roentgenograms of dead material and the study of cleared specimens.[7,14]

SPINE

In the case of the primary vertebral centers, the chart accomplishes conventionalization without serious distortion of Bardeen's classical publications.[1] Hanson's articles supply data for the late epiphyses.[4] Roederer and Lagrot's[11] data on fusion of laminae are controversial and may not stand the test of time. They have been employed in the chart because they are based on studies of the living and, in a general way, seem to agree with casual uncontrolled observations in this laboratory.

NUTRIENT CANALS

Harman,[5] working in Sullivan's labora-

* In spite of this, it seems well to include the lesser tuberosity in the chart on the assumption that dissecting room reports are dependable and that special tangential views of the anterior surface of the humerus in children of about three years will probably show this center in roentgenograms as well.

* From the Division of Roentgenology, Department of Medicine, University of Chicago.

tory at the University of Wisconsin, has shown that there is much variation in the number, location, and direction of the nutrient canals of the femur. Presumably the same is true of other long bones, but if one keeps in mind the possibility of variation, it is probably safe and of some value to recognize the existence of a conventional pattern. According to this convention, the canal, in its passage from the cortex to the medulla, is directed toward the end of a long bone at which the epiphysis appears latest and fuses earliest or, in those bones equipped with only one epiphysis, toward the end lacking an epiphysis.

VARIATIONS

Only the most common of the congenital anomalies are shown in the column at the left, but it is planned to publish later Part II dealing in some detail with anomalies of trunk and extremities, and Part III showing the normal and anomalous development of the skull.

The method of charting is a modification of that used in the textbook of Schinz, Baensch and Friedl.[13]

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DEVE

KEY INDICATING AGE RANGE DURING WHICH:-

- ■■■■■■■■■ PRIMARY CENTERS OF OSSIFICATION APPEAR
- ●●●●●●●●● SECONDARY CENTERS OF OSSIFICATION APPEAR
- ---------- CENTERS OR GROUPS OF CENTERS REMAIN UNFUSED WITH NEIGHBORING CENTERS OR GROUPS OF CENTERS
- ▬▬▬▬▬▬▬ CENTERS OR GROUPS OF CENTERS FUSE WITH NEIGHBORING CENTERS OR GROUPS OF CENTERS

VARIATIONS

SPINE

CERVICAL 1:- SEPARATE POSTERIOR NUCLEUS APPEARING AT FUSION OF LAMINAE
CERVICAL 2:- AT PUBERTY EPIPHYSES FOR BIFID SPINOUS PROCESSES APPEAR
CERVICAL 3, 4, 5, 6 & 7:- EPIPHYSES FOR TIPS OF BIFID SPINOUS PROCESSES
COSTAL CENTERS FOR 6TH & 7TH (CERV. RIBS)
LUMBAR 1:- COSTAL CENTERS (LUMBAR RIBS)
LUMBAR 5 AND SOMETIMES OTHERS:- TWO CENTERS FOR ARCHES (PERSISTENCE OF JOINT PREDISPOSES TO SPONDYLOLISTHESIS)

ADDITIONAL REGULAR SACRAL EPIPHYSES
AT PUBERTY TWO PLATES APPEAR FOR EACH BODY, ALSO CENTERS FOR COSTAL AND ARTICULAR PROCESSES

STERNUM

4TH SEGMENT OF STERNUM MAY DEVELOP FROM 3RD WITHOUT SEPARATE CENTER
AT PUBERTY EPIPHYSES MAY APPEAR AT CLAVICULAR NOTCHES

REGULAR DISTRIBUTION OF RIB EPIPHYSES

EPIPHYSES FOR HEAD ONLY:- 11TH & 12TH
EPIPHYSES FOR HEAD AND ONE TUBERCLE:- 1ST AND 7TH TO 10TH
EPIPHYSES FOR HEAD AND TWO TUBERCLES:- 2ND TO 6TH

SHOULDER

RARELY ACROMIAL TIP DEVELOPS ANOMALOUSLY FROM SEPARATE PRIMARY CENTERS ON BOTH SIDES OF THE BODY REMAINING PERMANENTLY SEPARATED FROM SCAPULA BY CARTILAGE PLATE

ELBOW

DOUBLE CENTER FOR OLECRANON
PERFORATION OF FLOOR OF OLECRANON FOSSA
EPICONDYLIC PROCESS DEVELOPED FROM MEDIAL SIDE LOWER END OF HUMERUS (RARE)

WRIST & HAND

SEPARATE CENTER FOR ULNAR STYLOID
EXTRA EPIPHYSES BASE OF METACARPAL 2
HEAD OF METACARPAL 1
OS CENTRALE BETWEEN NAVICULAR
CAPITATUM AND LESSER MULTANGULAR
OS TRIANGULARE BETWEEN TRIQUETRUM AND ULNAR STYLOID

PELVIS & HIP

EPIPHYSES FOR PUBIC TUBERCLE AND ANGLE AND FOR ISCHIAL SPINE
OSSICLE AT ACETABULAR MARGIN (MISCALLED OS ACETABULI)

KNEE

MULTIPLE PATELLAR CENTERS
TWO CENTERS FOR HEAD OF FIBULA
SEPARATE CENTER FOR TIBIAL TUBEROSITY AND MEDIAL MALLEOLUS
FABELLA IN LATERAL HEAD OF GASTROCNEMIUS

ANKLE & FOOT

EXTRA EPIPHYSES BASE OF 2ND METATARSAL, HEAD OF 1ST METATARSAL

ANOMALOUS ANKLE BONES

LEFT FOOT

			FETAL				
			LUNAR				
			1	2	3	4	5
SPINE	CERVICAL 1	ARCHES (2) ANTERIOR CENTER FOR ARCH TIPS OF TRANS. PROC.		■	----	----	----
	CERVICAL 2	ARCHES (2) BODY (1 OR 2) DENS (2) SUMMIT OF DENS INFERIOR EPIPHYSEAL PL.		■	----	----	----
	CERVICAL 3 TO 7	ARCHES (2) BODIES LATE EPIPHYSES {GIRLS / BOYS}		■	----	----	----
	THORACIC 1 TO 12	ARCHES (2) BODIES LATE EPIPHYSES (5)			■■■	----	----
	LUMBAR 1 TO 4	ARCHES (2) BODIES LATE EPIPHYSES (7)			■■■	----	----
	LUMBAR 5	ARCHES (2) BODIES LATE EPIPHYSES (7)				■■	----
	SACRAL 1 TO 5	ARCHES (2) BODIES			■■■	■■■	■■
	COCCYGEAL VERTEBRAE	BODIES					
STERNUM	STERNUM CHARTED FROM CONFLICTING AND INCOMPLETE DATA.	MANUBRIUM 1ST SEGMENT (1) 2ND " (2) 3RD " (2) 4TH " (2) XIPHOID (1)					■■
	RIBS	HEAD TUBERCLE (1 OR 2)					
SHOULDER	CLAVICLE	INNER END					
	SCAPULA	CORACOID CORACOID EPIPH. (2) SUBCORACOID MARGIN OF GLENOID EPIPH. AT BORDER & ANG. (2) ACROMION (2)					
	HUMERUS	HEAD GREATER TUBERCLE LESSER TUBERCLE					
ELBOW	HUMERUS	CAPITELLUM & LAT. ½ TROCHLEA MEDIAL ½ TROCHLEA LATERAL EPICONDYLE MEDIAL EPICONDYLE					
	RADIUS	HEAD TUBEROSITY (INCONSTANT)					
	ULNA	OLECRANON					
WRIST & HAN	CARPALS	NAVICULAR LUNATUM TRIQUETRUM PISIFORM:- {GIRLS / BOYS} GREATER MULTANGULAR LESSER MULTANGULAR CAPITATUM HAMATUM					
	RADIUS	DISTAL END {GIRLS / BOYS}					
	ULNA	DISTAL END					
	PHALANGES & METACARPAL 1	BASES					

ELOPMENT OF THE HUMAN SKELETON

PART I. — TRUNK AND EXTREMITIES

AL PERIOD | INFANCY | CHILDHOOD

AR MONTHS | CALENDAR MONTHS

4 5 6 7 8 9 10 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 TO 24 | 3 4 5 6 7 8 9 10 11

(LAMINAE)

(LAMINAE)

ORDER OF FUSION 7-6-5-4-3

(LAMINAE)

ORDER OF FUSION 12 TO 1

(LAMINAE)

ORDER OF FUSION 4-3-2-1

(LAMINAE)

(LAMINAE)

ORDER OF FUSION 2-1-4-3

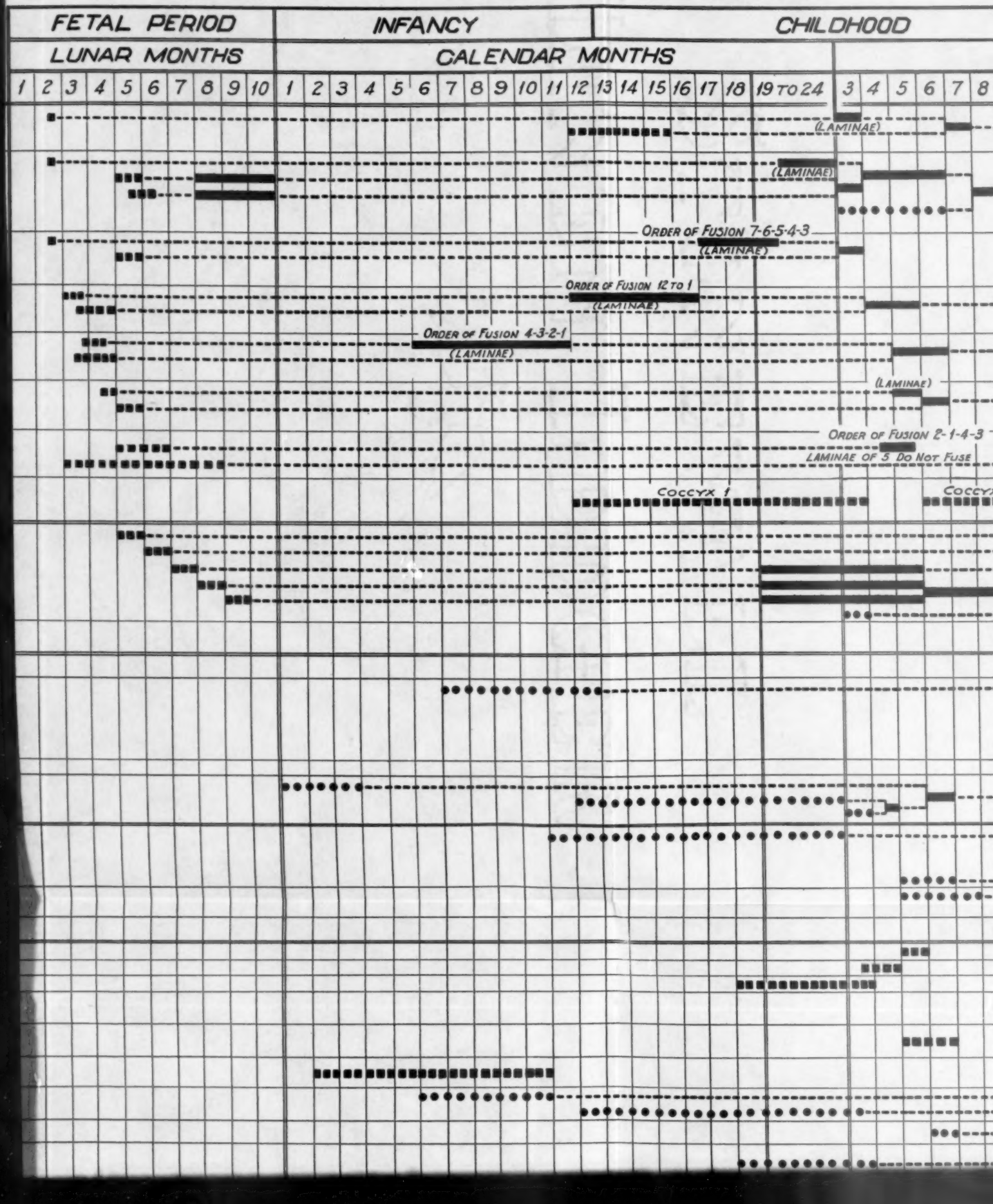
LAMINAE OF 5 DO NOT FUSE

COCCYX 1

COCCYX 2

DEVELOPMENT OF THE HUMAN SKELETO

PART I. — TRUNK AND EXTREMITIES



TON

PAUL C. HODGES — DIV. OF ROENTGENOLOGY
DEPT. OF MEDICINE — UNIVERSITY OF CHICAGO

1933

PUBERTY | MATURITY

YEARS

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 | 26 TO 30 | 31 TO 70 | OVER 70

PART II
ANOMALIES OF TRUNK AND EXTREMITIES

—•—

PART III
NORMAL AND ABNORMAL DEVELOPMENT OF SKULL

4-3

ORDER OF FUSION OF SACRAL SEGMENTS 5-4-3-2-1

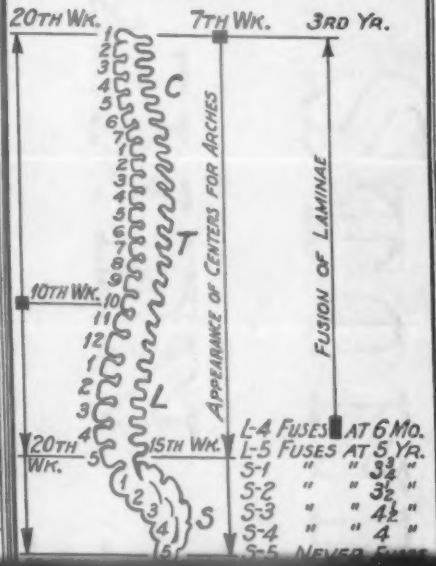
COCCYX 2

COCCYX 3 & 4

■ PART OF SPINE WHERE CENTERS FOR BODIES OR ARCHES FIRST APPEAR

▬ PART OF SPINE WHERE LAMINAE FIRST FUSE

→ INDICATES SEQUENCE OF APPEARANCE OF CENTERS OR FUSION OF LAMINAE



Epiphyses for Head and Two Tubercles:- 2nd to 6th

Shoulder

Rarely Acromial Tip Develops Anomalously from Separate Primary Centers on Both Sides of the Body Remaining Permanently Separated from Scapula by Cartilage Plate

Elbow

Double Center for Olecranon
Perforation of Floor of Olecranon Fossa
Epicondylic Process Developed from Medial Side Lower End of Humerus (Rare)

Wrist & Hand

Separate Center for Ulnar Styloid
Extra Epiphyses Base of Metacarpal 2
Head of Metacarpal 1
Os Centrale Between Navicular Capitatum and Lesser Multangular
Os Triangulare Between Triquetrum and Ulnar Styloid

Pelvis & Hip

Epiphyses for Pubic Tubercle and Angle and for Ischial Spine
Ossicle at Acetabular Margin (Miscalled Os Acetabuli)

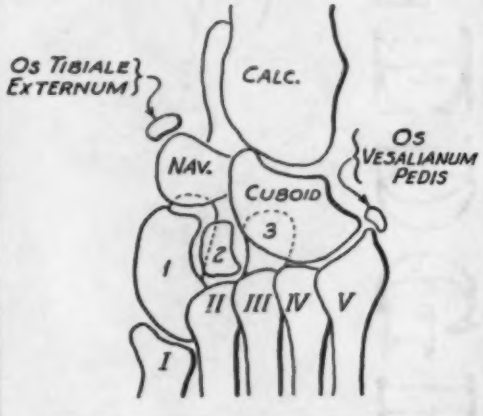
Knee

Multiple Patellar Centers
Two Centers for Head of Fibula
Separate Center for Tibial Tuberosity and Medial Malleolus
Fabella in Lateral Head of Gastrocnemius

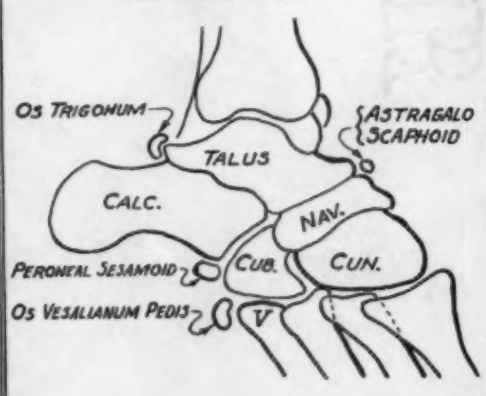
Ankle & Foot

Extra Epiphyses Base of 2nd Metatarsal, Head of 1st Metatarsal

Anomalous Ankle Bones
Left Foot



Left Foot
Lateral Aspect

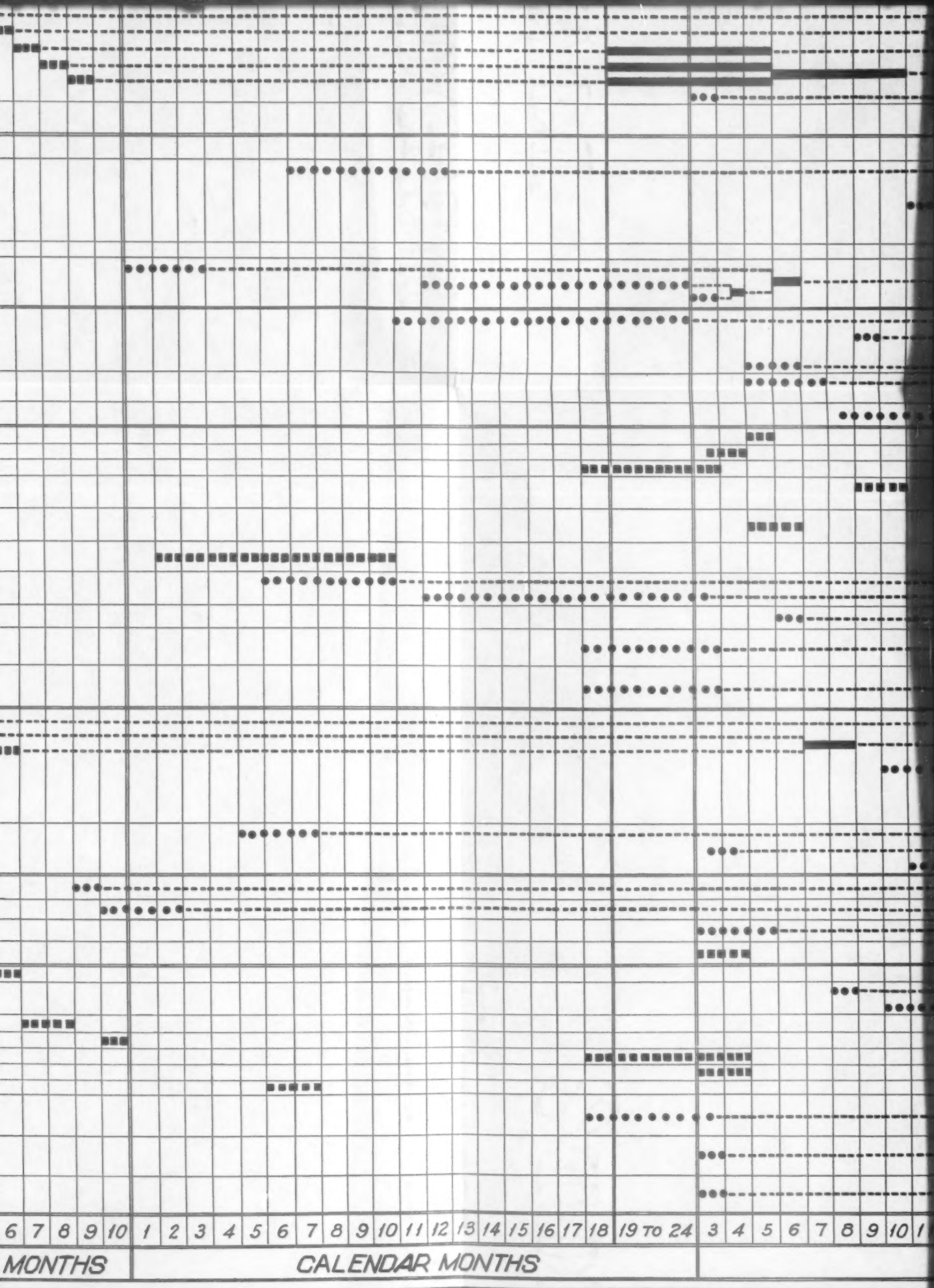


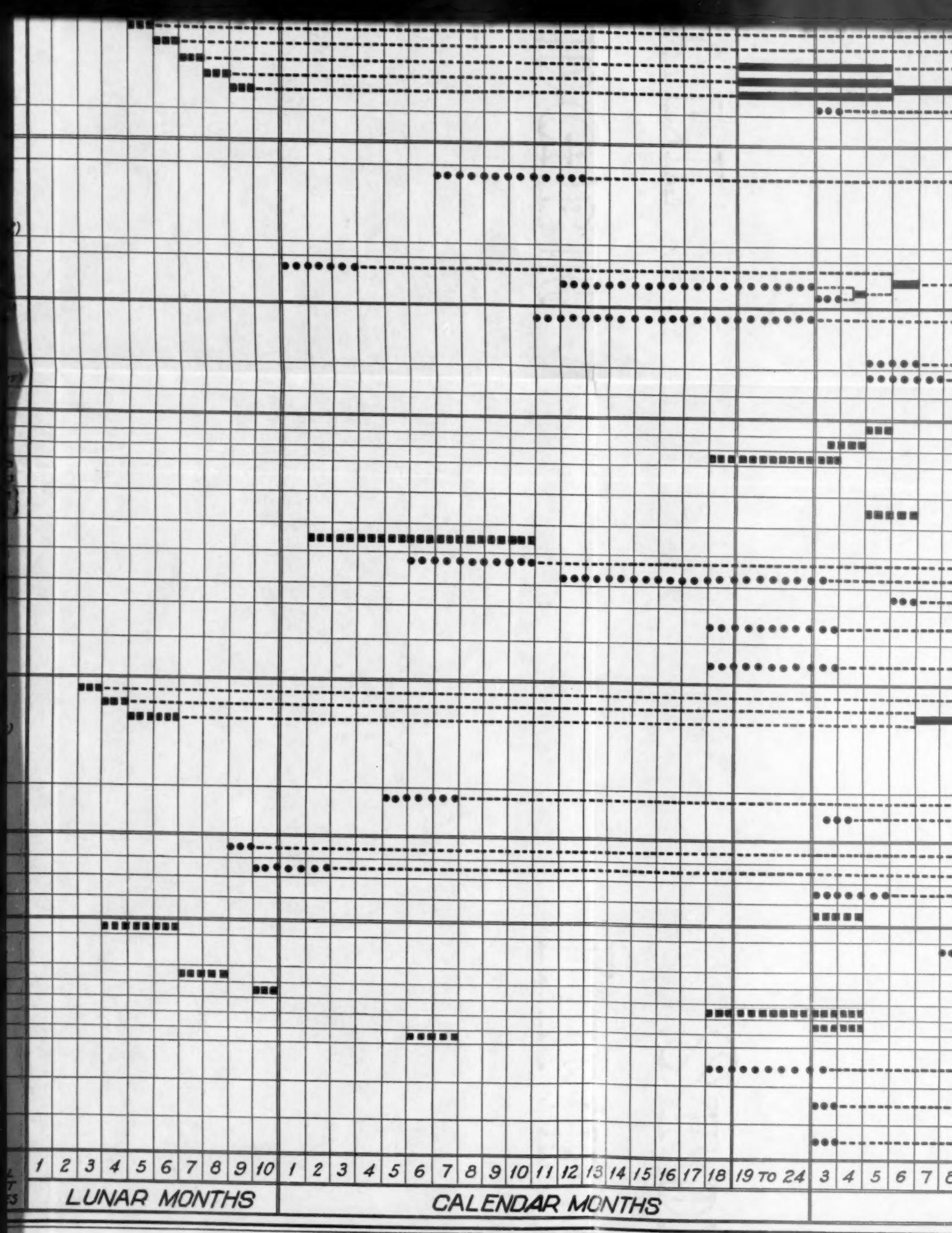
Sternum	Sternum	Charted from conflicting and incomplete data.	Manubrium 1st Segment (1) 2nd " (2) 3rd " (2) 4th " (2) Xiphoid (1)
	Ribs		Head Tubercle (1 or 2)
Shoulder	Clavicle		Inner End
	Scapula		Coracoid Coracoid Epiph. (2) Subcoracoid Margin of Glenoid Epiph. at Border & Ang. (2) Acromion (2)
	Humerus		Head Greater Tubercle Lesser Tubercle
Elbow	Humerus		Capitellum & Lat. ½ Trochlea Medial ½ Trochlea Lateral Epicondyle Medial Epicondyle
	Radius		Head Tuberosity (inconstant)
	Ulna		Olecranon
Wrist & Hand	Carpals		Navicular Lunatum Triquetrum Pisiform:- Girls / Boys Greater Multangular Lesser Multangular Capitatum Hamatum
	Radius		Distal End Girls / Boys
	Ulna		Distal End
	Phalanges & Metacarpal 1		Bases
	Metacarpals 2 to 5		Heads
Pelvis & Hip	Innominate		Ilium Ischium Pubis Triradiate Strip (3 centers) Iliac Crest and Spine Pubic Symphysis Ischial Tuberosity
	Femur		Head Greater Trochanter Lesser Trochanter
Knee	Femur		Distal End
	Tibia		Proximal End
	Fibula		Head
	Patella		Center for
Ankle & Foot	Tarsals		Calcaneus Epiphyses Girls / Boys Talus Cuboid Navicular 1st & 2nd Cuneiforms 3rd Cuneiform
	Tibia and Fibula		Distal Epiphyses
	Phalanges & Metatarsal 1		Base
	Metatarsals 2 to 5		Head

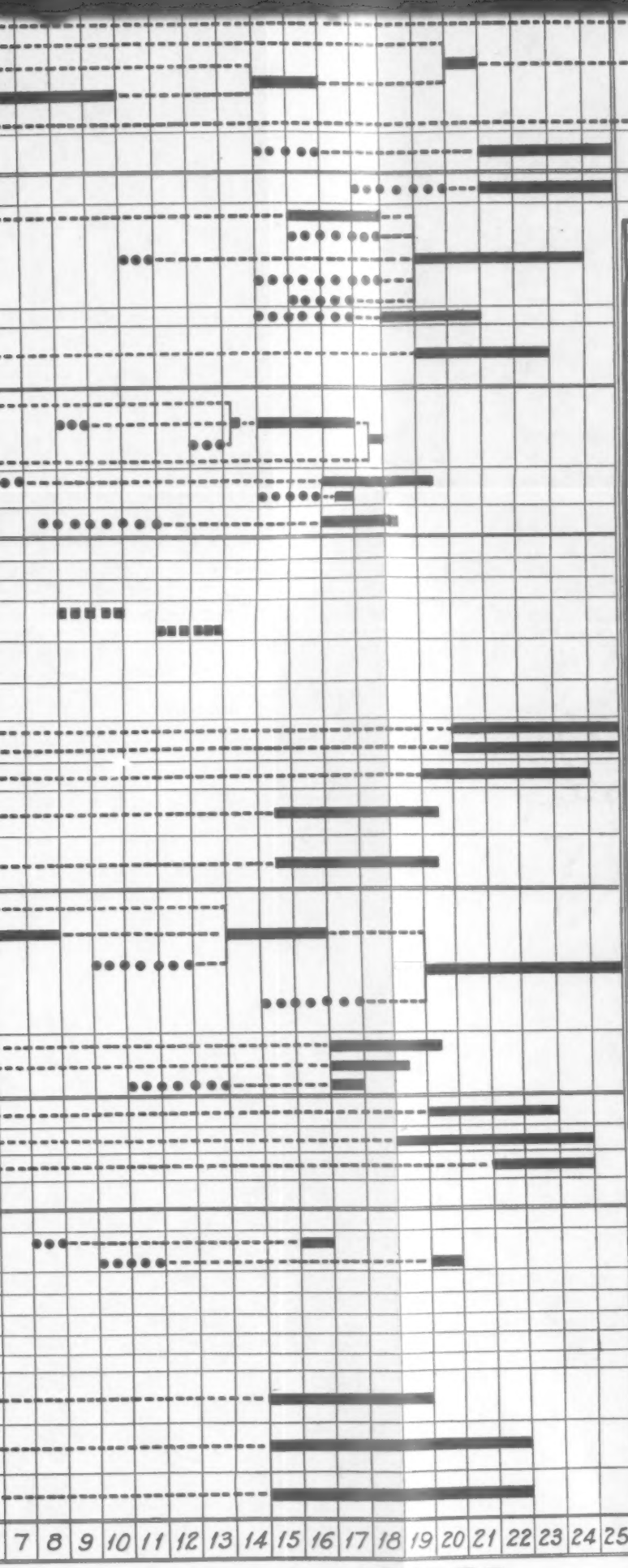
NOTE:-
Of the Hundreds of Recognized Skeletal Variations it has been possible to list here only a few of the more common ones

1 2 3 4 5 6

LUNAR M


6 7 8 9 10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 TO 24 3 4 5 6 7 8 9 10 1
MONTHS
CALENDAR MONTHS

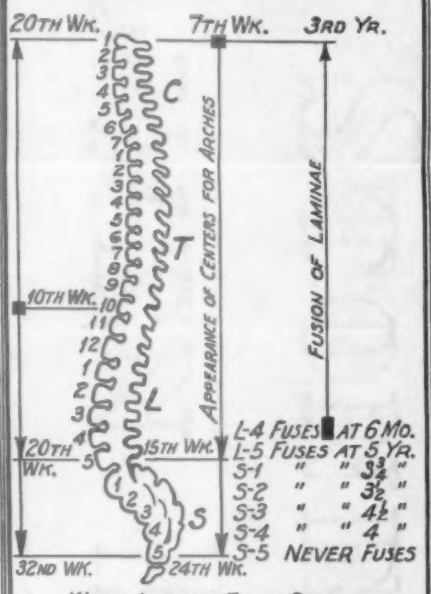

1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 TO 24 3 4 5 6 7
LUNAR MONTHS
CALENDAR MONTHS



■ PART OF SPINE WHERE CENTERS FOR BODIES OR ARCHES FIRST APPEAR

■ PART OF SPINE WHERE LAMINAE FIRST FUSE

→ INDICATES SEQUENCE OF APPEARANCE OF CENTERS OR FUSION OF LAMINAE

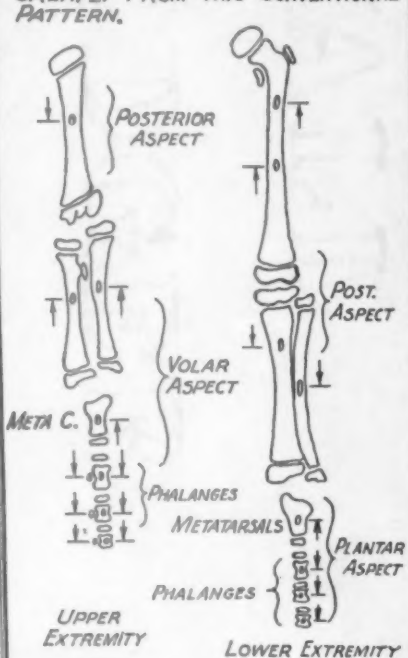


WEEKS INDICATE FETAL PERIOD

MO. & YR. INDICATE POST NATAL PERIOD

NUTRIENT CANALS

INDIVIDUAL CASES MAY VARY GREATLY FROM THIS CONVENTIONAL PATTERN.



7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26 TO 30	31 TO 70	OVER 70

YEARS

Vol. XXX, No. 6

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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19th Annual Meeting: Cleveland, June 10-11, 1934.

EDITORIAL

MARCH FOOT OR PIED FORCÉ

ROENTGENOLOGISTS should be interested in the condition known as "march foot" or "pied forcé" for two reasons: first, because it was one of the first conditions to be investigated by the roentgen ray, and second, because of the possibility of its confusion with a malignant process. The first roentgen-ray observations were made by Stechow of the Prussian Guard, at Madrid, in 1897. He discussed fracture of the metatarsals as the cause of swollen feet in soldiers, having seen thirty-six cases. The condition was first described in 1855 by Breithaupt who observed cases of persistently edematous and painful feet occurring in soldiers. He called it "Fussgeschwulst," that is, a traumatic inflammation of the tendon sheaths. It was later described by Chapotot and Boisson in an article entitled "Le Pied forcé." Reports of this condition have appeared from time to time in the foreign literature but comparatively little has been published in American journals.

March foot is a subacute, painful affection of the forepart of the foot, occurring chiefly about the shafts of the metatarsals and surrounding soft parts. It has an insidious development with slowly increasing pain, which first arises after prolonged excessive effort, later after ordinary exercises, and ultimately may become continuous, often incapacitating the patient. Since the introduction of motor transports for the rapid movement of troops the condition has become much rarer, though it still occurs among soldiers. It is also found among the civil population in those engaged in similar heavy occupations, such as pedlars, and it may occur in those engaged in sports, such as golfing; cases have been found in women engaged in strenuous standing and weight-carrying work, for example, waitresses, shop assistants, and nurses.

Clinically the condition is characterized by swelling which appears on the dorsum of the foot, usually in the region of the shafts of the second and third metatarsals invading the soft tissues and bone. The skin may be slightly reddened and definitely tender to palpation. This later may be accompanied by bony swelling of the shaft of one of the metatarsals, usually the second or third. The swelling of the shaft of the metatarsal is due to the presence of callus which has arisen around an oblique or V-shaped fracture of the shaft of the metatarsal at the junction of the middle and distal thirds, the fracture occurring there because it is slightly weakened due to the entry of the nutrient vessels into the metatarsal shafts at that point.

Dodd[1] has recently called attention to the condition and he believes that "March Foot is a complication of subacute flat foot occurring in architectually weak feet. In these muscular spasm and exhaustion alternate, and as the latter supervenes, the stout ligaments of the foot are gradually stretched, and direct trauma to the bony skeleton of the foot occurs. These undamped shocks will produce effects in the weakest bones first, and the slender, resilient metatarsals fall into this category.

"As the flat-foot develops, the feet take up the usual flat-foot position, pointing outwards, instead of approximately straight forwards. Thus the body weight is no longer carried through a line passing between the first and second metatarsals, parallel to their shafts, and distributed

[1] Dodd, Harold. Pied forcé or march foot. *Brit. J. Surg.* July, 1933, *21*, 131–144.

squarely on to the five heads of the metatarsals, but falls largely in an oblique direction on the inside of the foot, i.e., on the first most . . ., the second next, then the third, and to a lesser degree on the fourth and fifth. If the foot is architecturally weak, as appears to be frequently the case in March Foot, then a hypermobile first metatarsal will roll away from this weight, and as a congenitally short metatarsal cannot reach to the ground to carry the strain, then the weight must pass primarily on to the second metatarsal and in decreasing amounts through the third, fourth, and fifth." The first metatarsal is a much larger and stronger bone than either the second or third so that structural changes resulting from abnormal stress will be shown much earlier in the second and third than in the first metatarsal. Extra stress does, as Dodd says, occur on the first metatarsal, as is shown by the thickening and increased density of its outer border, this sign being present in all the fourteen cases which he studied roentgenographically. In flat-foot, after the first metatarsal, the brunt of the misplaced weight falls on the second metatarsal and when the supporting power of the muscles and ligaments of the calf and foot is exhausted, the second metatarsal would be the first to "crack" because it has a much more slender bony structure than the first metatarsal. Dodd concludes that march foot is probably an auto-traumatic complication of subacute flat-foot in an architecturally weak foot, rather than a separate clinical entity.

The roentgen findings are of considerable importance. There is usually bony swelling of somewhat fluffy, bulbous outline, due to callus, at the junction of the distal and middle thirds of either, and occasionally even of both, of the shafts of the second or third metatarsals, much less often of the fourth or fifth, and extremely rarely of the first. The bony proliferation occurs around a partial or complete fracture, usually without displacement. In the early stages there is increased density of the shafts of the metatarsals where the interosseous muscles arise, namely, the second, third, fourth, and inner border of the fifth. The outer border of the first metatarsal shaft is also dense, but the change is most marked in the second or third metatarsal shafts. Other bulbous swellings may occur about the shafts of the proximal phalanges of the second, third and fourth toes. These bulbous swellings are probably due to localized periostitis at the site of attachment of the flexor tendon sheaths. The bony proliferations about the shafts of the metatarsals may be so dense at the time the patient is roentgenographed as to completely obscure the subperiosteal type fracture and, owing to the bony reaction to the trauma, namely, an excessive periostitis, the condition is frequently mistaken for sarcoma of the shaft of the metatarsal or for syphilitic periostitis. It is imperative that the condition known as march foot be thought of as a possibility in the differential diagnosis as otherwise the patient may be subjected to an unwarranted operation or amputation.

SOCIETY PROCEEDINGS CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Pittsburgh, Pa., Sept. 25-28, 1934.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual meeting: Cleveland, 1934.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Cleveland, Ohio, June 11–15, 1934.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.
Annual meeting: 1934, to be announced.

Radiological Section, Baltimore Medical Society
Secretary, Dr. W. B. Firor, 1100 N. Charles St., Baltimore.
Meets third Tuesday in each month from September to May.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. R. T. Taylor, Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.
Annual meeting: Richmond, Va., November, 1933.

Brooklyn Roentgen Ray Society
Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.
Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. R. G. Willy, 1138 N. Leavitt.
Meets second Thursday of each month October to May inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

Cleveland Radiological Society
Secretary, Dr. Otto Glasser, Cleveland Clinic.
Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida Radiological Society
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.
Meetings held twice a year, May and November.

Illinois Radiological Society
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Michigan Association of Roentgenologists
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Detroit, Mich., February, 1934.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February and April. Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N.C.
Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.
Three meetings a year—January, May and November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif.
Meets annually, during meeting of California Medical Association

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, Graduate Hospital.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital.
Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.

South Carolina X-Ray Society
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Meets at time and place of South Carolina State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY

Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

UNIVERSITY OF WISCONSIN ROENTGEN CLUB

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P. M.

VIRGINIA ROENTGEN RAY CLUB

Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA

Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.
Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

INDIAN RADIOLOGICAL ASSOCIATION

Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta.
Meets annually in January, and at such places and times as the Council may appoint.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY

Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE

Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE

Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA

Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)

Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY

Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA

Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucarest, Rumania.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY.

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summer time.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN

Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY

Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK

Secretary, Dr. H. Scheuermann, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND

Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY

Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION

c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY

Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

JAPANESE ROENTGEN SOCIETIES AND ROENTGENOLOGICAL LITERATURE

EDITOR'S NOTE: The following interesting letter was received by Dr. Paul C. Hodges of the University of Chicago and it has been forwarded to the Journal with the thought that the information it contained concerning Japanese roentgen societies and literature would be of interest to the readers of the Journal:

MY DEAR DR. HODGES:

I want to acknowledge your letter, dated April 5, which reached me unusually late for some unknown reasons; this may partly explain my delay in answering your letter.

Although we have many articles published in many different magazines about Roentgenology nowa-days, most of them are only written in the Japanese languages and only few have foreign abstracts; for example, the official Journal for the Nippon Roentgen Society has no foreign abstracts.

In this circumstance I feel it exceedingly inconvenient to show our works in Japan to the foreign colleagues at the present time. The "Literaturregister" is the book which has been published by Dr. K. Fujinami and his associates, Keio University, Tokyo, and this contains all the names of literatures about Roentgenology and Physical Therapy in Japan 1912–1929, translated into German language. I am sending this to you and I hope it may help you to give some idea of our works in Japan in Roentgenology.

The Nippon Society has been established in 1922 and the first official Journal of the society was published in July of this year. Since then the Journal of the Nippon Roentgen Society is published six times a year in every month. Unfortunately, the articles are written only in the Japanese language without foreign abstract at the present time. The Nippon Roentgen Society has a local branch in main cities in Japan and every branch holds a scientific roentgen meeting regularly once every month. In April every year the Nippon Roentgen Society holds its annual general meeting cooperated with the other branches of Medicine at one of the large cities which have also their meetings at the same place respectively. The Nippon Roentgen Society has about 700 regular members at present time and the president-elect of this year is Professor Kaichiro Manabe, who is the director of the Physical therapy Department of the Tokyo Imperial University. Besides the official Journal of the Nippon Roentgen Society, we have two private magazines for Roentgenology and Physical therapy. One is the "Igaku-shimpo" and the other is the "Jitsusen-Irigaku." The former is published every month and edited by Dr. Juichi Ogawa, Kobe, and the latter is edited and supervised by Professor K. Fujinami, Keio University, Tokyo and published every other month, six times a year.

The "Sakura" film has made its first appearance as the Japanese-made film very recently and is on sale from the beginning of May of this year after repeated experimentations and observations of many Roentgenologists who all agree "Sakura" films are available as X-ray diagnostic films and the slight inferiority of its quality to the imported films is to be compensated by the prices which are almost 25% cheaper than the foreign films.

Our works in St. Luke's hospital are recently very much enlarged and we have about 60–70 patients daily in our Department of Roentgenology and Physical Therapy, keeping the staff busy.

The St. Luke's Medical center will have its dedication ceremony on the fourth and fifth of July for the New Building of Nursing Dormitory and part of the hospital building. The buildings for the out-patient and Roentgenology are not built yet, so that we don't know whether we are moving to the new building or not.

Yours Sincerely,

TAKEO INOUYE

Vol. XXX, No. 6

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., 105 Rutledge Ave., Charleston, S. C.

A COMBINED SINUS AND MASTOID HEAD REST

By RALPH E. HERENDEEN, M.D., *and* FRANK HUBER, M.D.
NEW YORK CITY

THIS apparatus, primarily for the roentgenography of the nasal accessory sinuses and mastoids, is based on the principle of adjusting the head rest for the different positions of the patient's head without moving or changing the angle of the tube.

The device is essentially a tunnel for an 8″×10″ cassette which can be tilted at any desired angle in one plane with or without a simultaneous 15° tilt to either side. By this means the various postures used in sinus and mastoid roentgenography may be obtained with a constantly vertical central ray. A transparent top of some celluloid material may be optionally incorporated in the tunnel supplanting the opaque top and, with the employment of a mirror below, aids somewhat in positioning the head, notably in the nose-forehead sinus view and in the mastoid view, but this innovation, originally reported by Petersen,[1] is by no means indispensable. Metal masks are placed over the tunnel top to block out secondary radiation. For the sinus series the diameter of the orifice in the mask is from 5 to 6 inches and for the mastoid 4½ inches. The cone or cylinder used must necessarily produce a beam of slightly greater diameter.

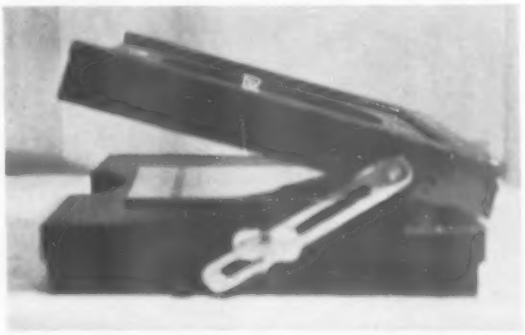

Fig. 1. Lateral view of head rest with tunnel tilted at 20°. (Usual angle for nose-forehead sinus.)

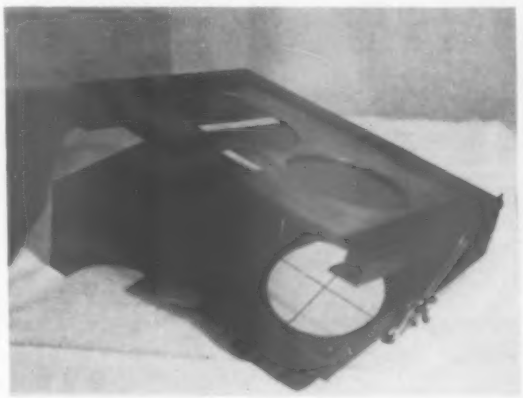

Fig. 2. Oblique view of head rest with 15° tilt in two planes for examination of right mastoid. Note reflections of centering lines in mirror below.

The actual procedure of examination is to seat the patient before a small table on which the head rest is placed. The central ray of the vertical roentgen-ray beam is made to pass through the center of the circle on the tunnel top. Technical factors are those of non-Potter-Bucky head roentgenography. Immobilization or rather steadying of the head either by lateral clamps or a weighted canvas band is sometimes desirable. This is preferable to raising or lowering the tube for direct immobilization of the head with the cone or cylinder.

The sinus views are taken in the following sequence:

1. Lateral (right or left)—center external

[1] Petersen, B. W. A simple quick centering apparatus for stereoscopic mastoid roentgenography. Am. J. Roentgenol. & Rad. Therapy, 1932, *28*, 561–562.

FIG. 3. Set-up for right lateral position.

canthus, head true lateral, tunnel horizontal.

2. Nose-chin (Waters)—center tip of nose, elevated ½ inch by small cork block, tunnel horizontal.

3. Nose-forehead—center root of nose (glabella), using mirror before inserting cassette, tunnel tilted 12 to 20°, usually 17°. This latitude of inclination varies directly with the size of the nose and is consequently smaller for children.

4. Vertico-mental (Hirtz)—chin extended to upper edge of orifice and mask, head hyper-extended, center midway between chin and larynx, increase the tunnel angle until the central ray passes through the sella point (1 inch in front and above the external auditory meatus). By this maneuver the base line of the skull approaches the horizontal. It is frequently necessary to tilt the tube slightly; the shorter the neck and more receding the jaw, the greater the angle to which the tunnel must be raised.

Similarly in investigation of the mas-

FIG. 4. Set-up for nose-chin (Waters) sinus position.

FIG. 5. Set-up for nose-forehead sinus position.

Fig. 6. Set-up for vertico-mental (Hirtz) sinus position.

Fig. 7. Set-up for oblique or Rhese position for optic foramen.

toids the patient is seated, although for children the reclining position may be used. A 15° double tilt of the tunnel is obtained and the tube centered to either right or left opening in the mask. The head is placed so that its median sagittal plane is parallel to the plane of the tunnel, the chin always pointing down and out. The external auditory meatus is centered using the mirror. Right and left sides are taken. Stereoscopic views are made by shifting the tube towards the occiput.

In addition to these routine views the apparatus is well adapted to several accessory views. The optic foramen and the relation of the canal for the optic nerve to the posterior ethmoidal and sphenoidal cells is well shown by the Rhese or oblique position in which the orbit is centered and the head rests on three points: the outer portion of the eyebrow, the cheek bone, and the side of the nose. The tunnel is horizontal. The Arcelin position for the petrous tip and an oblique view of the mastoid utilizes the same set-up except that the center point is midway between the external canthus and mastoid tip. Stereoscopic views may be made in both of these positions by employing the same technique as in the mastoid stereo. It is possible to include both these views in a single exposure by using the mask with the large opening and the technique for the optic foramen.

The tunnel also lends itself to plain or stereoscopic lateral views of the jaw by elevating one end piece. Here, however, the tube must be angled as for the usual jaw view.

Adoption of the principle set forth by Loughery and Stecher[2] supplies a method of obtaining the four sinus views or stereoscopic views of both mastoids on a single 10″×12″ cassette. This is accomplished by

[2] Loughery, T. P., and Stecher, W. R. An improved stereoscopic mastoid examination. Am. J. Roentgenol. & Rad. Therapy, 1933, *29*, 112–115.

means of a suitable mask and by insertion of the cassette in its long axis.

By the use of this combined sinus and mastoid head rest the technique of examination is simplified as much as the requirements of multiple and accurate positioning allow. Standardization of views is a distinct aid in interpretation. Results are reproducible.

The apparatus is suitable for all the views necessary in a complete investigation of the sinuses and mastoids, and supplants more complicated and expensive mechanisms.

FIG. 8. Set-up for right mastoid position. Note reflection of field in mirror.

FIG. 9. Set-up for nose-forehead in illustrating centering of head in mirror.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

SKELETAL SYSTEM

Frejka, Bedrich. Kyphosis adolescentium. *J. Bone & Joint Surg.*, July, 1932, *14*, 545–554.

Kyphosis adolescentium was first described by Scheuermann, 1921. Mau, Sorrel and Delahaye, Buchman, and others, attribute the disease to the changes in the spinal epiphyses and consider this condition to be definitely similar to Legg-Perthes-Calvé's disease of the hip joint. The author states, however, that this opinion does not tally with the fact that this affection is not limited to the period from twelve to twenty-five years of age, for it is frequently observed in the first decade of life, before the epiphyses are developed.

Mau, quoted by the author, distinguishes three stages in the development of kyphosis adolescentium: (1) the stage of onset, (2) the stage of deformity which exists usually for a long time, two or more years with gradual increase of the condition and (3) the stage of reparation. Mau emphasizes the fact that the latter stage depends upon the period of growth and the roentgen ray shows that the irregular, toothed, indistinct outline of the vertebral bodies again becomes clear, the atrophy disappears, the anterior edges of the vertebral bodies develop areas with spurs which change in severe cases, with the result that the anterior part of

the body becomes saddle-shaped. Mau explains this condition as originating in the overloading of the spine at the time the epiphyses are developing. The blood vessels nourishing the epiphyses become injured and finally obliterated which results in a necrosis of the epiphyses.

Scheuermann and Mau call the small toothed projections at the upper and lower anterior borders of the vertebral bodies the special epiphyses and Mau suggests in detail an analogy to the epiphyses of animals. However, Schmorl does not regard these as typical epiphyses, their function being to join the vertebral body firmly to the vertebral plate. This union is so firm that occasionally, by trauma to the epiphysis, a triangular section is torn from the body of the vertebra.

Schmorl's theory of the cause of kyphosis adolescentium is that of a disturbance in the development of the intervetebral discs. In the roentgenogram, rounded or toothed projections of the intervertebral plate into the bone tissue of the body can be seen. With the overloading due to trauma, the tissue of the nucleus pulposus presses into the openings of the body, causing an atrophy of the bone which often extends into the spongiosa. Further progress is stopped by reactive changes which result in a sclerotic condensation and a walling off of the "knot" or "whorl." These small furrows of bone, Schmorl considers as typical of adolescent kyphosis.

Frejka, in spite of the authority of Schmorl, does not consider that this thoroughly explains all the phenomena which accompany kyphosis adolescentium. It fails to explain the blurred outline of the anterior part of the bodies of the vertebrae in the early stages of the affection, and also does not explain the typical cycle of two or three years as described by Mau. He reports 3 cases, all of which showed evidence of tuberculous involvement of the spine. In the first patient the illness began at the eighth to the tenth year, in the second the symptoms were first noticed between the fourth and sixth years and in the third, at twenty-three years of age. The onset of the disease in these cases has no relation to the development of the vertebral epiphyses. In the first case, the roentgen findings were identical with the picture of Scheuermann's cases and in addition showed added shadows of an oblong abscess which completed the picture of the tuberculous process. In the second and third cases, the roentgenograms showed varying degrees of saddle-shaped deformity of the anterior borders of the vertebral bodies, condensation of the margins of the bodies, and at the time of the early examinations, indistinct anterior borders of the bodies. The author did not consider these findings as typical of Scheuermann's kyphosis. He thinks they are due to an unusual form of tuberculosis.

He believes his cases, as described very completely in this paper, are interesting from a twofold point of view, showing first, that one of the causes of the "stiff, round back" may be tuberculosis; and second, that an inflammatory process of tuberculosis of the spine may pursue a mild course for a long time, without definite clinical or roentgen evidence, and the actual condition may not be demonstrable until after a period of several years. It is obvious that all cases of round, stiff back cannot be explained as due to a latent tuberculosis, for this is only one of the causes. It has been demonstrated in recent years by Italian authors that the disturbances of the hypophysis can also produce the typical clinical picture of kyphosis adolescentium.—*R. S. Bromer.*

CONGDON, RUSSELL T. Spondylolisthesis and vertebral anomalies in skeletons of American aborigines. With clinical notes on spondylolisthesis. *J. Bone & Joint Surg.*, July, 1932, *14*, 511–524.

The anatomical material on which this study is based comprises nearly 200 skeletal remains of American aborigines, obtained in the course of archeological investigations in the Columbia River region. Bilateral separation of the neural arch was found in 10 subjects. This occurred in the fifth lumbar vertebra in 9 subjects, in the fourth lumbar in one; in one of the 9 subjects, the bilateral defect occurred in both the fourth and fifth lumbar vertebrae. These subjects also in some instances showed marked changes in the structure of the first sacral body, related to changes in the accompanying fifth lumbar vertebra. In 5, in which the defective fifth was superimposed upon the first sacral segment in the position assumed during the life of the subject, definite evidence of spondylolisthesis was found.

In the living subject, existence of the defective neural arch cannot be demonstrated by the roentgen examination. When, however, spondylolisthesis is present and there is considerable space between the two parts of the divided arch, the defect may be visualized.

Its existence is suggested when the anteroposterior diameter of the vertebra involved in spondylolisthesis is greater than that of the other lumbar vertebrae, as seen in the lateral roentgenogram. Bilateral separation of the arch results in a marked instability of the lumbar spine. Congdon believes that the increasing knowledge, gained from roentgenographic examination and operative findings, indicates that this defect is the fundamental etiological factor in a rather large group of cases of spondylolisthesis.—*R. S. Bromer.*

Lawson, John D. Lateral dislocation of the vertebra. *J. Bone & Joint Surg.*, April, 1932, *14*, 387–390.

Lateral dislocations of the vertebrae are still rare, few having been reported in the literature. Lawson reports 3 cases:

1. A lateral dislocation of the fourth lumbar vertebra upon the fifth.

2. A fracture of the body of the twelfth dorsal; marked narrowing of the eleventh intervertebral disc; lateral dislocation of the twelfth upon the eleventh, the displacement being approximately three-fourths of an inch.

3. Fractures of the transverse processes, left side, of the first, second, third, fourth and fifth lumbar vertebrae; fractures of the transverse processes, right side, fourth and fifth lumbar; transverse fracture of the sacrum extending from the lumbosacral joint laterally to the sacroiliac joint on the left; fracture of the tip of the fifth lumbar spinous process; lateral dislocation of the fifth lumbar on the first sacral vertebrae.

The case histories are illustrated with roentgenograms of the three patients.—*R. S. Bromer.*

Kleinberg, Samuel. Unilateral subluxation of the lumbosacral joint. *J. Bone & Joint Surg.*, April, 1932, *14*, 384–386.

Kleinberg's case is that of a patient complaining of persistent back disability after a trauma of a back wrenching nature. Nonstereoscopic roentgenograms showed a change in the relations between the fifth lumbar vertebra and the adjoining fourth lumbar and the sacrum. Less of the fifth lumbar could be seen on the right side than on the left. The right lumbosacral articulation was not visible, while the left was clearly outlined. Stereoscopic films revealed a definite lesion. The fifth lumbar vertebra was rotated forward on the right side and the articular processes were one in front of the other instead of lateral to each other as on the left side. The rotary dislocation of the fifth lumbar, Kleinberg believes, accounts for the flattening in the right lumbar area on clinical examination, the sensitiveness to pressure, the painful limitation of motion, and the disability of which the patient complained.—*R. S. Bromer.*

Willis, Theodore A. Backache; an anatomical consideration. *J. Bone & Joint Surg.*, April, 1932, *14*, 267–272.

Willis states that the human back is particularly subject to aches of muscle, joint and ligamentous origin because of its complicated structure, its adoption of the upright posture, and because of its frequent defects of development in the lumbosacral area, some of which are serious mechanical faults Because of its complicated structure, careful anatomical study is necessary for the explanation of many cases of backache. At points where the normal curves of the spine meet, the back is particularly liable to strain and irritation from any source, with resulting sprain or arthritis. Exaggeration of the curves from habit, fatigue, or other cause increases such liability.

Willis discusses the following anomalies of the spine and their relation to backache: variations in the number of presacral vertebrae, variations in the number of rib-bearing segments, occasional appearance of half vertebrae, irregular fusions of segments. Asymmetrical sacralization and defective lumbosacral articulation are of definite interest only as they provide points of lessened resistance to the stresses of function, with susceptibility to muscle and ligament injury. The presence of this anomaly, as demonstrated by the roentgen ray, does not solve the problem of pain in the back and is not in itself an indication for operation. Separate neural arch is a condition which has long been recognized but its frequency of occurrence and clinical importance have not been generally recognized. Its relation to spondylolisthesis is now well known. It is the result of defective ossification of the vertebrae. Symptoms of this condition are those of ligamentous injury, acute or chronic, and referred pain. Until actual displacement takes place, the roentgen evidence is usually lacking.—*R. S. Bromer.*

POMERANZ, MAURICE M. Intrapelvic protrusion of the acetabulum (Otto pelvis). *J. Bone & Joint Surg.*, July, 1932, *14*, 663–686.

Pomeranz defines the condition which he describes in his paper as a non-traumatic, chronic progressive arthritis of the hip joint, characterized by intrapelvic protrusion of the acetabulum and head of the femur. This lesion was recognized by Otto in 1824, and although occurring infrequently, is of considerable importance to orthopedic surgery and obstetrics. Variations in the pathological findings and in the wide range of etiological factors have occasioned a wide difference of opinion in regard to the disease. An overwhelming majority of writers, Pomeranz states, believe it is not a disease entity, but rather the end-result of an inflammatory process. Some regard it as a juvenile osteoarthritis or other chronic deforming process, the deformity being manifested years after recovery from the original acute infection. Numerous bacterial agents have been believed to be concerned in the process, including the tubercle bacillus, the gonococcus, the streptococcus, etc. From an etiological standpoint other conditions such as tabes, lues, metastatic malignancy, the arthritides, gouty diathesis, coxitis, chondrodystrophy, and trauma have been considered.

In incidence, it is twice as common in females as in males. Persons in middle life are usually affected, there being only one reported case at an advanced age and several under twenty years. In 49 of the 79 reported cases the condition was unilateral. The chief complaint is that of a slowly progressing painful coxitis, with the development of a limp, the patient finally assuming a wabbly gait and ultimately finding it impossible to spread the limbs or to stoop. Abduction and rotation of the femur is distinctly limited.

The diagnosis even in early cases may be made by the roentgen examination. The acetabulum projects into the pelvis as a rounded, globular, dome-shaped mass. The degree of protrusion varies from a few millimeters to 4 or 5 centimeters in severe cases. As the acetabulum migrates, it inclines upward, inward, and forward, so that it may project above the ramus of the pubis, spreading towards the obturator fossa and at times materially encroaching upon and constricting it. In extreme cases, the protrusion extends up to the sacroiliac joint and, as a result, unilateral constriction of the pelvis occurs. The inner wall of the acetabulum may be shell-like in thinness or else it may show as an extremely dense, eburnated wall. As it extends into the pelvis, a low-grade osteoplastic process is initiated, whereby nature splints the yielding joint by the formation of a dense wall on the inner aspect of the acetabulum parallel to its projecting margin. The external margins of the acetabulum project outward over the neck of the femur as irregular serrated vegetative formations. In the typical deformity, there is preservation of the integrity of the femoral head. This would seem to be a necessary prerequisite, since the femoral head must maintain its boring qualities. Occasionally, there may occur slight deviations from the general configuration of the head; thus it may appear mushroomed, or at other times slightly elongated, with a spear-like or pear-like shape. Bone excrescences sometimes extend over the femoral neck. The constricted acetabular inlet, combined with the osteophytic projections of the head, effectually locks the femoral head within the acetabulum. As the femur follows the receding acetabulum, there appears to be foreshortening of its neck, a change, however, more apparent than real. As the head of the femur is submerged within the acetabulum, the trochanters approach the lateral margins of the pelvis and incline posteriorly. The great trochanter impinges on the ileum and the lesser trochanter approaches the ischium; thus the femur cannot be rotated outward or backward. The arrest of the trochanters at the lateral margins of the pelvis limits the deformity and further migration of the femur is impossible. The periosteum on the inner wall becomes ossified.

Pomeranz reports 6 cases. He discusses the etiology, and concludes that it seems advisable to recognize two different classes of intrapelvic protrusion: an acute type probably infectious in origin, and a chronic type occurring in the course of any disease, resulting in an osteomalacia of the hip joint. In the first case if the infection or inflammation has involved essentially or accidentally the acetabular surface of the hip joint, the femoral head remains intact and protrusion quickly develops. If the infection is severe and involves the head of the femur and the acetabulum, there is necrosis of the head and bony ankylosis may result before the deformity occurs. The second type may occur in polyarthritis and in general osseous diseases, such as syphilis, osteomalacia and Paget's dis-

ease. In this instance, the lesion in the hip is but an incident in the general deformity. In many reported cases there is evidence of an arthritic process elsewhere, commonly in the sacroiliac joint and the spine, and often in the knees, elbows and wrists. Pomeranz asks, "Is not the Otto pelvis an atypical but essentially non-specific arthritis of the hip joint?" and suggests that we abandon the conception of the specificity and individuality of this lesion.—*R. S. Bromer.*

Cary, N. Austin, and Barnard, Leonard. Arthrokatadysis of the hip joint. *J. Bone & Joint Surg.*, July, 1932, *14*, 687–689.

In 1929, Verrall reported a case in which the lesion presented a sinking-in of the acetabulum, resulting in limitation in movement of the hip joint. He suggested the name "arthrokatadysis," meaning literally "subsidence of a joint," and suggested that it may be a localized osteomalacia. He drew attention to the fact that there was no narrowing of the pubic arch as seen in true osteomalacia. The authors present 2 cases which they believe belong in this group. In the first case the roentgen examination showed a sinking-in of the left acetabulum into the pelvis, with thinning of the acetabular floor. The head of the femur, which was enlarged, was thoroughly engaged in the center of the acetabulum. In the second case the examination showed a localized dislocation of the acetabulum and the head of the femur, much more marked on the left side, with the neck apposing the rim of the acetabulum which accounted for the limitation of motion which was demonstrated clinically.

Hertzler has described a pathological condition of the hip joint under the title, "osteo-arthritic protrusion of the acetabulum." Cary and Barnard prefer the term "arthrokatadysis" as they believe it more correctly describes the condition.—*R. S. Bromer.*

Snodgrass, L. E. Perthes' disease. *J. Bone & Joint Surg.*, April, 1932, *14*, 314–324.

Snodgrass states that the purpose of his paper is: (1) to present the record of an unusual case of Perthes' disease with roentgenograms; (2) to stress an intermediate type of deformity between coxa plana and the normal hip; (3) to call attention to the similarity of the reported findings in Perthes' disease to those found in normal bone repair; (4) to point out a mechanism whereby the stability in these hips is increased; (5) to discuss briefly the etiology of the condition.

His study is based on 36 cases of Perthes' disease, and on 6 cases which showed moderate flattening of the socket with or without slight flattening and lateral displacement of the epiphysis of the femoral head, but always with coxa valga deformity of varying degree.

(1) The case of unusual interest is one showing changes in the femoral head while the socket remained constant. This case is illustrated with four serial roentgenograms.

(2) The intermediate type of deformity is the type of hip which shows, in the roentgenogram, a rather flat socket with the femoral head and neck in a position of coxa valga, sometimes with a depression in the roof of the acetabulum and often with a slight lateral displacement of the femoral epiphysis. His 6 cases of this type have all been observed for at least three years without the development of coxa plana, although one case entered the out-patient department with a complaint of pain in the hip. These subnormal hips represent an intermediate type of deformity between the normal hip, on the one hand, and the mushroom type of coxa plana, on the other. A series of films containing a film each of a normal hip, a subnormal hip, a mushroom type of coxa plana, a capped type of coxa plana and a congenital dislocated hip arranged in the order named, affords an interesting study in acetabular variations.

(3) Snodgrass states that he is not in harmony with the view of Lippmann that the histopathologic changes in Perthes' disease probably represent the result of an aseptic infarction in the femoral head area. On the contrary, he is impressed with the similarity of Lippmann's findings to some of the reported changes in normal bone repair in men and animals. If the more recent work which has been done in bone repair is accepted, the theory of vascular occlusion is unnecessary in the explanation of the findings in Perthes' disease as recorded by Lippmann.

(4) If the view is accepted that the acetabula of these subnormal hips are flattened and widened from birth, then the question arises as to why these hips do not commonly dislocate under the stress and strain of active childhood. In the development of coxa plana, the shortening of the neck and the straightening of the head and neck into a coxa valga destroy the short

arm of the lever—the head and neck at an angle of approximately 127° to the shaft of the femur —which with internal rotation, is so productive of dislocation in the normal hip. There is a resultant increase in stability, for the joint is adjusted to withstand the extremes of internal rotation, flexion and abduction

(5) One of the first theories of etiology was the infectious, but after almost twenty years of effort by careful workers no organism has been demonstrated consistently in this condition. The theory of vascular occlusion with infarction does not carry the weight it did before the more recent studies in bone repair were made. Likewise, the rather strictly limited age incidence for the disease is not easily explained by infection or vascular occlusion The belief, expressed by some, that the head flattens the acetabulum, disregards the screw-like action of the hip as shown by Walmsley. He demonstrated that the arrangement of the fibers in the capsule of the joint tends to force the head with a screw-like motion into the socket in extension which is the normal weight-bearing position. If Walmsley's observations are correct, one would expect a deepening effect on the socket by the femoral head, even though flattened.

Snodgrass states that if the bone changes in the femoral head are assumed to be examples of normal bone repair in an area of injury caused by a flattened socket, the question of what institutes the process still remains unanswered. The irritation produced by the incongruity of the parts might produce a local hyperemia which would yield a rarefaction of the femoral head of sufficient degree to permit a crushing fracture by body weight. External trauma might initiate the same course of events in a shorter period of time.—*R. S. Bromer.*

LAPIDUS, PAUL W. Longitudinal fractures of the patella. *J. Bone & Joint Surg.*, April, 1932, *14*, 351–379.

The purpose of Lapidus in this paper is to call attention to longitudinal fractures of the patella. These fractures, although thought to be a great rarity are, in his belief, rather common and as a rule unrecognized. Transverse fractures of the patella are common. The literature on longitudinal fractures is scarce. Roentgen rays have greatly helped in the recognition of the fracture. He reports 12 cases profusely illustrated with roentgenograms. Correct diagnosis is important for the purpose of proper treatment, especially in legal cases. The clinical picture is clear cut: history of injury, localized linear tenderness over the lateral border of the patella, effusion in the knee joint (usually hemorrhagic), comparatively negligible disability. Lapidus thinks that in the majority of his cases there must have been a combination of direct violence with the indirect action of muscular pull.

It is important to remember that the usual routine method of roentgenography of the knee, anteroposterior and lateral views, does not as a rule show a longitudinal fracture of the patella, largely because of the superimposed image of the femur over the patella in the anteroposterior view. Lapidus employs a technique consisting of a series of views: anteroposterior; oblique with the knee slightly rotated externally about 15°, while the patient lies on his abdomen with the film beneath the patella; oblique in certain cases with internal rotation of the knee; and, finally, a view made with the patient on his abdomen, the film placed beneath the lower end of the femur while the knee is flexed as sharply as possible The tube in this last position is tilted so that the central ray passes parallel to the articular surface of the patella between it and the condyles of the femur, directed upward from the leg to the thigh. This view may also be made with the patient kneeling on the film. The leg is flexed at the knee as much as possible without discomfort. The tube is tilted, fixing the central ray the same as in the previously described technique, between the patella and the condyles of the femur, but in reversed direction—from the thigh toward the leg. Both patellae may be taken on one film in the same exposure, the central ray being directed between the closely approximated knees, while both legs are flexed at the same angle. If in some cases in very recent longitudinal fracture with considerable effusion, it is difficult to flex the knee, aspiration of the knee joint should be performed before the roentgen examination. Lapidus recommends that in the lateral oblique position, the central ray be directed through the head of the fibula. This gives a clear picture of the lateral part of the patella without superposition of the shadow of the femur.

Congenital malformation of the patella may easily be mistaken for longitudinal fracture, and should always be considered in the differential diagnosis. Bipartite or multipartite patellae are not so extremely rare. A more or less marked

defect over the upper outer border of the patella often occurs. The patella may ossify from two centers, the place of fusion being a site of lessened resistance. Trauma, causing separation of the fusion between the two centers of ossification, may give the appearance of a patella bipartita. The location, size and shape of the fragments may be of some aid in the differentiation of longitudinal fracture from congenital anomalies. In most cases of such fracture the outer fragment is larger than in cases of malformation, and the line of fracture usually runs over the junction of the middle and the outer quarters in a vertical direction. The accessory center of ossification is smaller in the majority of cases, as compared with the main part of the patella, and is usually located over the outer upper part of the patellar border, the condition being usually bilateral and symmetrical. The history of injury associated with the other findings, suggesting the traumatic nature of the lesion, is of importance in the differential diagnosis. Injuries of the knee joint with a pre-existing congenital anomaly may sometimes make the precise diagnosis difficult. It is especially important in compensation and legal cases, to have as a routine, the roentgenograms of the healthy patella for comparison.

Therapeutic value of repeated aspiration of the effusion in the knee joint is emphasized in these cases. Longitudinal fracture may lead to a quite prolonged disability if overlooked. If properly recognized and treated, complete recovery within six to eight weeks may be expected. No operative treatment should be employed.—*R. S. Bromer.*

Coley, Bradley L. Echinococcus disease of bone; report of two cases involving the pelvic girdle. *J. Bone & Joint Surg.*, July, 1932, *14*, 577–590.

Hydatid disease of the skeletal system is an extremely rare bone lesion. Coley reports 2 cases with involvement of the pelvis in each case, the roentgenograms being reproduced in the article. While relatively uncommon in the United States, hydatid disease has received intensive study in the countries where it is of frequent occurrence. In most countries osseous hydatid is considered a surgical curiosity. Of the bones involved, Walker and Cummins have shown that the pelvic girdle is the most frequent site of invasion, although cases have been reported involving practically every part of the skeleton. The question has been raised as to the probability of direct invasion from the pelvic peritoneum by the frequency of involvement of the bones of the pelvic girdle. Coexistent visceral and bone involvement is rare. The epiphyseal ends of the long bones seem to afford a site of predilection for the parasite, and it is now generally accepted that it is lodged in the bone by way of the blood stream.

The development within the bone is essentially slow and free from symptoms, and it appears to exhibit its greatest latency in osseous tissue. Pain, as a late phenomenon, usually follows some complication, such as infection or fracture. Loucks wonders that a high percentage of metastatic lesions has not been described for bone hydatid cysts, and in those cases, particularly where there has been a fracture, so that an opportunity has been afforded for the circulation of the viable elements of the organism by way of the ruptured vessels. In one reported case, secondary pulmonary cysts followed pathological fracture of the ileum.

Roentgenographic examination, according to Leborgne, in the early period of the disease reveals one or many small cystic areas, like bunches of grapes, rounded, punched out, sharply outlined, but without the reaction of condensing osteitis, i.e., without new bone formation at the periphery. At a later period when the bony enlargement is perceptible on palpation, alteration in the contour of the bone is observed, in the nature of a fusiform expansion without any sort of new bone formation. The bone is seen reduced to a shell under the periosteum which may be broken through spontaneously. The bony swelling has a typical, areolar appearance, infiltrated by large cavities of more or less irregular contour, but discretely outlined. The absence of bone hyperplasia classifies the lesion among the rarefying osteopathies and rules out osteomyelitis. Bone syphilis or gummatous conditions are encircled usually with a limiting ring of new bone formation. Central osteosarcomata, such as round cell or spindle cell, usually have a different clinical setting. In the differentiation of von Recklinghausen's disease, the rarefying areas have usually more clearly cut outlines in hydatid disease. In addition, osteitis fibrosa cystica usually involves other portions of the skeleton. Isolated bone cysts offer more diffi-

culty in differentiation. In the 2 cases here reported, the diagnosis was not made from clinical or roentgenographic studies but from the pathological examination. The disease can simulate roentgenographically a variety of bone conditions.

Intensive radiation therapy failed to check the disease or to alleviate the symptoms in Coley's cases.—*R. S. Bromer.*

DAVIDSON, ARTHUR J., and KURTZ, ARTHUR D. Giant-cell tumor (sarcoma?) of the astragalus. *J. Bone & Joint Surg.*, April, 1932, *14*, 410–411.

Davidson and Kurtz report a case of giant cell tumor of the astragalus following a traumatism of the left foot and ankle. On roentgen examination, on admission to the hospital, a diagnosis of crush fracture of the posterior third of the astragalus was made, the astragalocalcaneal joint being obliterated in the area of fracture. Astragalectomy was performed and the roentgenographic diagnosis was confirmed when the astragalus was exposed. But when traction was made upon the head of the astragalus to dislocate it outward, the entire bone collapsed into a number of fragments. Extreme thinning of the shell of the bone was observed, the internal structure being replaced by soft hemorrhagic tissue, with lighter areas of granulation tissue in it. Then, and then only, was tumor formation suspected. The laboratory report of the excised portions of the astragalus stated that the histological structure in the bone was that of a typical, benign giant cell tumor, except that in small areas there was more connective tissue present and fewer giant cells and many mitotic figures. It had many characteristics of a malignant lesion, and for this reason, it was not considered as entirely benign.—*R. S. Bromer.*

MILTNER, LEO J., and WAN, F. E. Giant-cell tumor of the os calcis. *J. Bone & Joint Surg.*, April, 1932, *14*, 406–409.

The authors report a case of giant cell tumor of the os calcis. This is a rare condition. Moore, in a recent survey of the literature, could collect only 4 cases, to which he added 3 more, found in a study of 1,740 bone tumors. Roentgenograms showed expansion of the os calcis in all directions, particularly on the lateral side. The cortex of the bone was apparently intact. The surface articulating with the astragalus appeared irregular and slightly absorbed. Numerous cystic spaces with intervening areas of condensation were seen inside the expanded bone. The microscopic diagnosis after operation was giant cell tumor with cyst formation.

The operation performed consisted of complete removal, through a wide "V"-shaped incision. The tendo achillis was lengthened and its lower end was fastened to the posterior-inferior part of the astragalus through drill holes in the latter. The foot was held in 45° plantar flexion during the tendon lengthening and, following closure of the wound, a long leg cast was applied with the ankle in the same position.

Concerning the prognosis for the function of the foot, the authors believe that if a calcaneal deformity develops at a later date, correction may be accomplished by posterior transplantation of the peroneus longus and tibialis anticus tendons. In the event that this should fail, permanent stability could be obtained by arthrodesis of the ankle and mid-tarsal joints. —*R. S. Bromer.*

BLOOD AND LYMPH SYSTEM

POPP L. Despre radiodiagnosticul arteriosclerosei periferice in legătură cu un caz de dysbasia intermittens angiosclerotica Erb, vindecat subiectiv prin diathermie. (Roentgen diagnosis of peripheral arteriosclerosis in connection with a case of dysbasia intermittens angiosclerotica Erb subjectively cured by diathermy.) *Cluj. med.*, Nov., 1931, *12*, 587–588.

Calcification of the peripheral blood vessels is often observed in routine roentgenograms of the extremities. According to the author's estimation, a diagnosis of arteriosclerosis should not be made in such instances unless there are other clinical symptoms present. He recently observed a case of calcification of the arteria dorsalis pedis and of the arteria tibialis posterior of the right lower extremity in an old diabetic fifty-five years of age, who suffered from dysbasia intermittens angiosclerotica Erb. A dietetic regimen associated with 20 seances of medical diathermy resulted in disappearance of the symptoms, the patient remaining well for over five years. The calcification of the peripheral vessels which was observed at the original examination remained the same, indicating that the symptoms were probably due to angiospasm of the smaller non-calcified vessels. The

diathermy by relieving the angiospasm led to improvement of the circulation and thus to arrest in the progress of the arteriosclerosis.—*T. Leucutia.*

ROENTGEN AND RADIUM THERAPY

Milani, Eugenio. Die Radiotherapie der entzündlichen Affektione. (Radiotherapy of inflammations.) *Strahlentherapie*, 1932, *43*, 401–440.

The history of the use of radiotherapy in inflammations is reviewed. Great progress has been made in this field in recent years. Most authors are agreed that small doses are to be preferred. The optimum dose is about 20 per cent of a skin erythema dose (120 German R units, about 260 French R and about 2½ Holzknecht). Generally large fields are preferred with moderately strong filtration (5 mm. aluminum), less frequently 0.5 mm. zinc or copper is used with moderately hard radiation, 100–150 kv., 20–25 cm. focus-skin distance and 2 ma. Of course this scheme is varied to suit the individual case. Secondary radiation from metals introduced into the body by iontophoresis has been developed by Ghilarducci and his school in Italy and has given excellent results in many cases.

Irradiation is particularly effective in acute and subacute localized forms of inflammation. The inflammatory diseases in which irradiation has been used successfully are divided into general suppurative inflammations, inflammatory diseases of the teeth, bones and joints, inflammatory eye diseases, inflammations of the genital organs, bronchopulmonary diseases and diseases of the central nervous system. Technique and results in each of these groups are reviewed.

Better results are obtained by direct irradiation of the focus than by indirect irradiation. There are four factors to be considered in the local action of the rays: the effect of the local irradiation on the circulation, the necrobiotic action on the cells of the infiltration, the action on phagocytosis and the action on the reticuloendothelial cells of the skin. In addition to the hyperemia which is the most striking visible effect of the rays, labile cells are destroyed and there is an active proliferation of the movable and fixed connective tissue cells. The observed facts seem to agree with Businco's theory that the doses of rays ordinarily used in inflammations not only increase the activity of the reticulo-endothelial system but also mobilize the histogenous wandering cells.—*Audrey G. Morgan.*

Windholz, Franz. Über die Strahlenbehandlung der Tonsillarhypertrophie zugleich ein Beitrag zur Strahlenatrophie der Tonsillen. (Roentgen therapy of hypertrophy of the tonsils and a study of the atrophy of the tonsils brought about by the rays.) *Strahlentherapie*, 1932, *43*, 327–348.

It is quite generally agreed that roentgen irradiation brings about a decrease in the size of hypertrophied tonsils due to the fact that lymphadenoid tissue is particularly sensitive to the action of the rays. The difference in percentages of results reported by different authors is due to the fact that in some of the collections of statistics the majority of the patients were children and in children the lymphadenoid tissue has a much greater capacity for regeneration so that recurrence of the hypertrophy is more frequently seen. In the author's material the hypertrophy was overcome in 77 per cent of the adult cases and 57–60 per cent of the cases in children. The clinical symptoms begin to improve even before there is any visible change in the size of the tonsils. In acute inflammations pain and fever stop within two to three days. Deep inflammations are also affected. The author reports one case of recurrent angina and chronic recurrent nephritis cured by irradiation of the tonsils and another of joint rheumatism. The number of bacteria in the lacunae and crypts is decreased. Some forms of bacteria, particularly hemolytic streptococci and diphtheria bacilli, disappear completely in the majority of the cases.

A detailed description of the histological appearance of the irradiated tonsils is given and illustrated with photomicrographs. The atrophy affects all the tonsillar tissues, epithelium as well as lymphadenoid tissue.

A lateral field is irradiated over each tonsil and if adenoids are to be reduced two fields on the nape of the neck are also irradiated. About 3–4 H of heavily filtered radiation is given to adults and 2–3 H to children; filter 0.5 mm. zinc and 1 mm. aluminum, 170 kv., focus-skin distance about 30 cm. Both sides may be irradiated the same day or on successive days. This irradiation is repeated twice at intervals of three days and the series repeated after an

interval of three to four weeks. After six more weeks a third series of the same dosage is given. Of course there will be variations from this scheme in individual cases.—*Audrey G. Morgan.*

MORAWITZ, P., and SCHATZKI, R. Frühsymptome des Krebses. (Early symptoms of cancer.) *Strahlentherapie*, 1931, *42*, 821–839.

The great majority of cancer patients still come for treatment too late for operation. Some progress has been made in early diagnosis, particularly by means of roentgen examination in cancer of the stomach and lungs. Roentgenograms are given showing pictures in early cases. But it still remains true that there are no early symptoms of cancer in the true sense of the word, that is, symptoms that show tumor in a stage when it is still local and operable. The patient generally does not come to the physician until it is too late or if he does come the symptoms are so indefinite and general that a diagnosis cannot be made.

There are only two possible ways of improving this situation. One is to find a specific cancer reaction comparable to the Wassermann reaction which is positive in the early stages and apply it to every elderly individual once or twice a year. It is impossible at present to say whether this can ever be attained. The other method, which seems more hopeful, is to find non-surgical methods of treatment of cancer, and among these radiotherapy seems to give the most promise.—*Audrey G. Morgan.*

BLUMENTHAL, FERDINAND. Die Organisation der Krebsbekampfung. (The organization of the fight against cancer.) *Strahlentherapie*, 1931, *42*, 809–820.

A great deal can be done to lower the mortality from cancer by organization of present resources without any specific cure for cancer. The author thinks the most important point is to induce patients to come for treatment early. Objections have been made to the propaganda for instructing the public in regard to the early symptoms of cancer as it is claimed that it gives the public a "cancer panic." But there is no way of instructing the public without making use of the press and while the articles published should be supervised by a physician, the doubtful and controversial scientific points must not be brought before the public but they must be told something positive and it is perfectly truthful to tell them that cancer can be cured if treated in the right way early enough. The idea that cancer is incurable is held quite generally not only by the laity but also by physicians and they also need instruction. The author has known of patients who went to charlatans because they were told by physicians that their disease was incurable, and there are many such cases. It is estimated that 60–80 per cent of the patients with female genital cancer now come for treatment in an inoperable condition. Certainly a large number of these patients could be saved by public instruction.

Courses should be instituted to keep physicians and students in touch with progress in cancer diagnosis and treatment. The practitioner cannot have all the technical means of diagnosis and treatment available himself but he should know where they can be obtained. There should be a center for cancer diagnosis and treatment in every province for there will always be cases which the general practitioner cannot be expected to diagnose and in many country districts and small towns there are no specialists capable of diagnosing cancer of the digestive tract, mouth, larynx, etc. Often even in larger hospitals there is only an internist and a surgeon, but no specialist in cancer.

Exploratory excision, if performed at all, should be done only by the surgeon immediately before operation.

Organization should not be carried too far but some control should be exercised over the practice of radiotherapy by private physicians. Those who have sufficient amounts of radium available and sufficient knowledge of the technique of radium and roentgen therapy should be allowed to continue practice but the centers should have large amounts of radium available and all cases requiring the use of such large amounts should be sent to the centers. There is only about 15 to 20 gm. radium in Germany and it is so divided up that only comparatively few places have enough for really effective treatment. A great deal of harm is done by private physicians practicing with inadequate apparatus, insufficient amounts of radium and insufficient knowledge of the subject.

The centers should also test new remedies proposed for cancer before they are allowed to be used on the public. A much disputed point is whether patients should be told that they have cancer. Generally every effort is made to

conceal the fact from them but this would no longer be necessary if the disease was not considered hopeless. Patients do not seem to object to going to the "Polyclinic for tumor patients" in Berlin and many of them seem to be glad that there is a place where they can get treatment from physicians with special knowledge and skill in such diseases.

Care must also be provided for the hopeless cases. They are now frequently rejected by hospitals because they are long drawn out and expensive cases to treat and are repulsive to the other patients in the ward and make them feel hopeless. There should be special hospitals or wards in connection with the centers for taking care of them.

The author does not advocate systematic examination of the whole populace for cancer. Some cases of cancer of the uterus have been discovered in America by examination of symptomless cases but it is almost impossible to give a patient a bill of health in regard to cancer of the digestive tract, for instance. The best that can be done is to keep him in the hospital for a week and subject him to expensive examinations and tell him that nothing has been found. That does not prove that he is free of cancer. Nor does the author believe in the compulsory reporting of cancer. That should be required only in diseases that endanger the public and cancer does not.—*Audrey G. Morgan.*

Böhmert, W. Die Todesfalle an Krebs nach dem alter 1901–1930. (Deaths from cancer according to age, from 1901 to 1930.) *Strahlentherapie*, 1931, *42*, 971–984.

Statistics are given for cancer deaths by age in different regions in Germany and an attempt made to draw some general conclusions from them in regard to whether cancer is really increasing. The author concludes that the increase in the number of deaths from cancer in Germany as a whole is almost entirely due to the fact that the average length of life in Germany has been increased in this period by almost twenty years and therefore much larger numbers of people reach the cancer age. A careful examination of the statistics in the regions where the causes of death are determined most carefully (Bavaria, Baden, Hamburg, Bremen, Berlin) shows that up to 1925 (the date of the last census) there has been no comparative increase but rather a decrease of cancer in all except the highest age group from sixty to seventy. The increase in this group is probably due to the fact that in former years old people of the poorer classes, particularly in the country, rarely had medical treatment.

Though the total statistics for Germany as a whole and particularly Prussia show a comparative increase, it is probable that in many parts of North Germany in former years many cases of death from cancer were attributed to senile weakness, ulcer of the stomach, etc. The most recent statistics for some districts (Hamburg and Bremen) seem to show that there has actually been an increase since 1925.

The following suggestions are made in regard to the collection of international statistics on cancer deaths. The deaths from cancer should be arranged according to decades and sex and compared with the total number of living individuals of the same age group. The next census should be utilized and the average number of deaths for that year and the two years before and after it calculated in proportion to the total number of living individuals in the census year. For a yearly comparison of the figures for the different countries the whole number of cancer deaths should be compared with the whole number of living persons over thirty years of age. The cancers should be classified according to the organs from which they originate. Only carcinomas and sarcomas should be counted as cancers. It is important in studying the causes of cancer to have the cases classified according to the regions from which they come. Patients dying in city hospitals should be classified in the district in which they live. The number of cures as compared to the total number of deaths should be calculated and also the causes of death in all members of the family. Questionnaires should be sent to patients treated for cancer and after the case is closed the answers should be sent to the public health authorities and evaluated statistically.—*Audrey G. Morgan.*

Roosen, Rudolf. Zur Krebsprognostik. (Prognosis of cancer.) *Strahlentherapie*, 1932, *43*, 188–189.

The effect of radiotherapy is brought about partly by stimulating the defensive forces of the surrounding tissues. Therefore, the more of the surface of the tumor in proportion to its mass is in contact with normal tissue, the more effective the rays will be. A tumor that is grow-

ing into the lumen of a hollow organ and has only a small surface in contact with normal tissue is much harder to affect than an infiltrating one which is surrounded on all sides by normal tissue. These facts should be taken into consideration in the prognosis of cancer. This helps to explain the good results of isamin blue treatment reported by Wehik in cancer of the stomach, for he mentions the fact that these were all infiltrating tumors of the stomach wall.

For this reason, too, in inoperable tumors all parts of the tumor that are not accessible to the action of the local defensive forces should be removed by operation, that is, these tumors should be changed in form so that they have the greatest possible surface in proportion to their mass in contact with normal tissue.—*Audrey G. Morgan.*

v. HABERER, H. Die Bedeutung der chirurgischen Behandlung für die Bekämpfung des Krebses. (The value of surgical treatment in the fight against cancer.) *Strahlentherapie*, 1931, *42*, 840–857.

The author reviews the results of surgical treatment in the different forms of cancer and describes illustrative cases of various kinds of cancer. He concludes that the results are not satisfactory and every effort must be made to improve them. Among the 10,035 radical operations that he has performed 1,277, or 12.5 per cent, have been for cancer. Barely 50 per cent of these were radically operable. Palliative operations had to be performed in the rest. In many of these cases there had been only slight general or local symptoms. He doubts the advisability of publicity on the subject of cancer as he thinks it will only alarm the people.

One reason why so many carcinomas are inoperable when they come to the surgeon is that they are incorrectly diagnosed at first by the practitioner. Post-graduate courses do not help the situation much. They are generally taken by the older men; the younger ones are too busy with the struggle for existence to take them. The instruction should be given while they are still students. All the early symptoms and methods of early diagnosis should be taught in medical school and the state examination should be made stricter. He cites two cases of bleeding nipple and one of painless afebrile inflammation of the skin (carcinomatous lymph gland infiltration) that were sent him by a colleague in a small town. He made a diagnosis of carcinoma and advised operation in all three; histological examination confirmed his diagnoses. If all insurance physicians made careful and minute examinations many such cases would be detected. The university clinics and the large hospitals can be used for consultation purposes.

Too much value is attached to negative roentgen findings. While there is no doubt of the great value of roentgen diagnosis all the clinical evidence should also be considered in negative cases. However unsatisfactory exploratory operation and excision is, it is sometimes necessary, particularly in carcinoma of the stomach.

Physicians can combat the tendency of patients to go to charlatans only by establishing greater confidence in the medical profession. Surgical treatment of so-called precancerous conditions is important in improving surgical statistics. Callous ulcers of the stomach and intestine and polyps of the large intestine frequently degenerate into cancer.

Further improvement can be brought about by changes in technique. For example, the author formerly resected carcinomas of the large intestine in one stage but he has found that the danger of the operation can be decreased by establishing an artificial anus above the intestinal suture. All technical improvements should be reported before the congresses and medical societies and as a matter of fact many carcinomas are now operated on radically that would have been considered inoperable twenty-five years ago.

Electrosurgery is a great technical improvement. The author has not yet dared to use it in stomach and intestinal operations. After electrocoagulation there is danger of secondary hemorrhage. This too may be overcome by improvements in technique. After-treatment is of great importance, particularly in carcinoma of the stomach. Diet, arsenic and in many cases insulin are valuable. He is not an enthusiast in regard to either preoperative or postoperative roentgen therapy though he acknowledges that he had a case of inoperable carcinoma of the breast rendered operable by radiotherapy. He operates on recurrences and metastases if they are operable; otherwise he uses radiotherapy and has often had good results, particularly in gland metastases.—*Audrey G. Morgan.*

Rózsa, Stephan. 10 Jahre Strahlenbehandlung des Sarkoms. (Ten years' radiotherapy of sarcoma.) *Strahlentherapie*, 1932, *43*, 719–726.

From 1920 to 1930, 129 sarcomas have been treated by radiotherapy in the roentgen section of the Municipal Hospital of Stettin. The number of patients alive and well after five years is 14.6 per cent of the whole number and the number of three-year cures 22 per cent. These results are practically the same as those of other authors. The treatment of sarcoma still remains chiefly surgical. Küttner obtained 30 per cent permanent cures by surgery and this figure has not yet been equalled by radiotherapy. An atttempt at radiotherapy should be made before performing severe mutilating operations.

In certain sarcomas, such as sarcoma of the tonsils and the nasopharynx, radiotherapy is apparently superior to surgery and in gland sarcomas it is of equal value. The results are not bad in sarcomas of the pleura, sarcomas of the uterus and in postoperative recurrences in sarcomas of the jaw. The results have not been improved even with large doses and Pfahler's saturation method but final judgment cannot yet be passed on this method.—*Audrey G. Morgan.*

Roffo, A. H. Durch radium vernarbtes Rontgenkarzinom. (Roentgen carcinoma healed by radium treatment.) *Strahlentherapie*, 1932, *43*, 757–766.

Many roentgenologists have died of roentgen carcinoma. In most cases surgery has been used without effect. It has generally been believed that further irradiation would make the condition worse but the author says this is a mistaken conception. When epithelial cells become neoplastic their biology changes and they react to rays just like any skin cancer. In support of this statement he describes a case of roentgen carcinoma in a colleague, Dr. Lucio A. Aravena, treated and healed by radium irradiation. Dr. Aravena began his work as a roentgenologist in 1904 when very little was known about protection from the rays. Soon a roentgen dermatitis developed which gradually developed into ulcers. He suffered intense pain and finally had to give up his work and all use of hands. By 1928 the ulcers had become distinctly carcinomatous. Dr. Roffo advised radium treatment. Molds were made of Columbia paste and adapted to the different fingers, also to enlarged ganglia at the elbow. The dosages for the different ulcers are given. The left index finger was the worst; it was ulcerated all over, was twice its normal size and the nail bed was transformed into a suppurating ulcer. It was treated by means of a plate containing 12 tubes of 10 microcurie-hours each mounted on an apparatus of Columbia paste. Diameter 7 mm., filter 1.5 mm. platinum, 192 irradiation hours; dose 23.04 mc.

Within two months the ulcers had all healed and now after a year they remain so.—*Audrey G. Morgan.*

Picchio, Carlo. La roentgenterapia a dosi frazionate e protratte. (Roentgen therapy in protracted fractional doses.) *Radiol. med.*, Jan., 1932, *19*, 1–38.

The author discusses the results of a year's experience with protracted fractional irradiation by Coutard's method. He finds that with this new technique improvement can be brought about in forms of tumors that were very little or not all affected by the previous methods. He discusses the biological and physical reasons for the advantages of this method and emphasizes the importance of a proper time distribution of the dosage which gives the radiation an elective action on the neoplastic tissue and spares the normal tissue to a remarkable degree. The rays applied by this method have a great penetrating power but they are absorbed very little by the superficial tissues. For this reason large doses can be used without danger of injuring the skin.

Some limitations of the method are also discussed. It cannot be applied to all forms of tumor for technical reasons and on account of its expense.—*Audrey G. Morgan.*

Faust, Herbert. Nachgewiesene schwere Schädigung des Perikards nach Röntgentiefenbestrahlung der Präkordialgegend. (Severe injury of the pericardium after roentgen deep irradiation of the precordial region.) *Strahlentherapie*, 1932, *43*, 749–756.

A boy of sixteen went to Professor Werner of Heidelberg for treatment in 1927. Roentgen examination showed a round tumor of the mediastinium for which he was given 1/10 of a skin erythema dose five times in the course of four days. Some months later he came to the author. His symptoms had grown worse. On

the basis of another roentgenogram a diagnosis of mediastinal tumor was again made. He was given four irradiations of 30 per cent of a skin erythema dose over three fields, anterior, posterior and lateral at the level of the tumor; fields 10×15 cm., focus-skin distance 40 cm. 36 per cent depth dose, 0.5 mm. zinc and 1 mm. aluminum filter, half-value layer 0.8 mm. copper. After five months he was given a second series of deep roentgen irradiations of the same kind. The tumor shadow decreased two fingers breadths. Re-examination in July, 1930, showed the same findings. In March, 1931, he was given 40 per cent of a skin erythema dose twice on back and chest. The size of the tumor decreased still further. In November, 1931, he came back in much worse condition. The heart and mediastinal tumor were much enlarged and there was a heart-shaped figure inside the "tumor" shadow, indicating pericarditis. Puncture showed clear yellow fluid. The patient was again given 30 per cent of a skin erythema dose twice. His condition continued to grow worse. Another puncture did not yield any fluid but only masses of fat and sebaceous material such as are seen in dermoid cysts. A diagnosis of dermoid cyst was now made and operation performed but the patient died two hours later. Autopsy showed a dermoid cyst the size of a man's fist in the right mediastinum and an extensive fibrinous pericarditis.

Exact roentgen diagnosis of mediastinal teratoma is very difficult. If there is a round, sharply outlined shadow in the mediastinum which shows no pulsation and does not move with respiration in a young patient at about the age of puberty or a few years after, teratoma or dermoid cyst should be suspected and an attempt made to obtain material by puncture from which a histological diagnosis can be made.—*Audrey G. Morgan.*

CASPARI, W. Die Bedeutung der unspezifischen Immunität für die Krebstherapie. (The importance of nonspecific immunity in cancer therapy.) *Strahlentherapie*, 1931, *42*, 899–913.

Nonspecific immunity can be brought about in various ways, best by the introduction of living cells into the body; the products of catabolism of the cells, particularly the albumin substances bring about immunity reactions The same biological process takes place when the cells of malignant tumors are broken down spontaneously in the body. The pathological process itself brings about counter-reactions in the body. The author calls these substances which are produced by catabolism of the tumor tissue necrohormones.

The process called nonspecific immunity probably consists of a direct or indirect stimulation of the reticulo-endothelial system.

Nonspecific immunity helps in recovery from cancer after operation. Whenever an individual has a large tumor there are probably cancer cells scattered through the organism. They need not necessarily be macroscopically demonstrable metastases. The natural defensive forces of the body are stimulated to overcome these foci by the operation, partly by detoxication and probably also partly by blood-letting. The author questions whether in tumor operations it is necessary to avoid bleeding as thoroughly as modern surgeons generally do.

Postoperative irradiation also helps to bring about nonspecific immunity. He is inclined to agree with those who advocate small doses. Too large local doses may paralyze the reaction of the reticulo-endothelial system instead of stimulating it. Non-specific immunity is best stimulated by general irradiation of the body with small doses. The effect of irradiation depends on the reactive capacity of the reticulo-endothelial system. If it is in good condition and capable of reacting vigorously there will probably be a temporary paralysis followed by compensatory hypertrophy. But if it is in bad condition, as in cachexia, the same concentration of necrohormones will injure it still more.

The author has succeeded in bringing about immunity in animal experiments by ligating the hilus of the spleen. Spleen cells are broken down and specific necrohormones enter the circulation and bring about an intense histiocytic reaction. It is possible that this method can be used in man also. Some authors are trying the effect of heat in bringing about nonspecific immunity. Coley has recently reported good results in cancer from the use of the malaria treatment introduced by Wagner-Jauregg for the treatment of paresis. The methods of nonspecific immunity are at least worthy of further study in the treatment of cancer.—*Audrey G. Morgan.*

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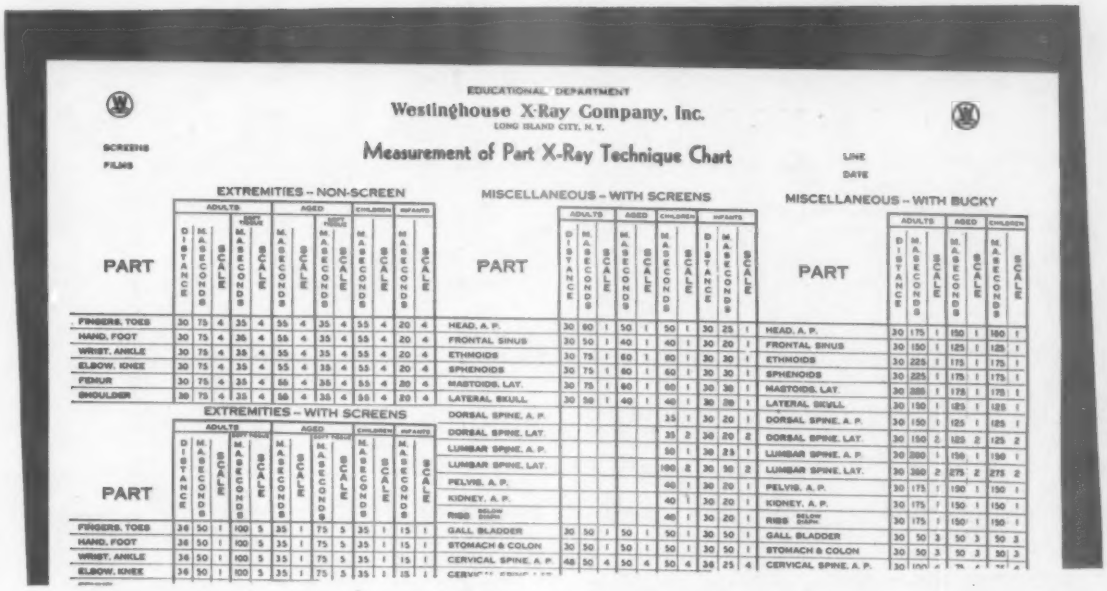

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Measurement of Part X-Ray Technique Chart

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EXTREMITIES – NON-SCREEN

PART	ADULTS DISTANCE	ADULTS M.A. SECONDS	ADULTS SCALE	ADULTS SOFT TISSUE M.A. SECONDS	ADULTS SOFT TISSUE SCALE	AGED M.A. SECONDS	AGED SCALE	AGED SOFT TISSUE M.A. SECONDS	AGED SOFT TISSUE SCALE	CHILDREN M.A. SECONDS	CHILDREN SCALE	INFANTS M.A. SECONDS	INFANTS SCALE
FINGERS, TOES	30	75	4	35	4	55	4	35	4	55	4	20	4
HAND, FOOT	30	75	4	35	4	55	4	35	4	55	4	20	4
WRIST, ANKLE	30	75	4	35	4	55	4	35	4	55	4	20	4
ELBOW, KNEE	30	75	4	35	4	55	4	35	4	55	4	20	4
FEMUR	30	75	4	35	4	55	4	35	4	55	4	20	4
SHOULDER	30	75	4	35	4	55	4	35	4	55	4	20	4

EXTREMITIES – WITH SCREENS

PART	ADULTS DISTANCE	ADULTS M.A. SECONDS	ADULTS SCALE	ADULTS SOFT TISSUE M.A. SECONDS	ADULTS SOFT TISSUE SCALE	AGED M.A. SECONDS	AGED SCALE	AGED SOFT TISSUE M.A. SECONDS	AGED SOFT TISSUE SCALE	CHILDREN M.A. SECONDS	CHILDREN SCALE	INFANTS M.A. SECONDS	INFANTS SCALE
FINGERS, TOES	36	50	1	100	5	35	1	75	5	35	1	15	1
HAND, FOOT	36	50	1	100	5	35	1	75	5	35	1	15	1
WRIST, ANKLE	36	50	1	100	5	35	1	75	5	35	1	15	1
ELBOW, KNEE	36	50	1	100	5	35	1	75	5	35	1	15	1

MISCELLANEOUS – WITH SCREENS

PART	ADULTS DISTANCE	ADULTS M.A. SECONDS	ADULTS SCALE	AGED M.A. SECONDS	AGED SCALE	CHILDREN M.A. SECONDS	CHILDREN SCALE	INFANTS DISTANCE	INFANTS M.A. SECONDS	INFANTS SCALE
HEAD, A. P.	30	60	1	50	1	50	1	30	25	1
FRONTAL SINUS	30	50	1	40	1	40	1	30	20	1
ETHMOIDS	30	75	1	60	1	60	1	30	30	1
SPHENOIDS	30	75	1	60	1	60	1	30	30	1
MASTOIDS, LAT.	30	75	1	60	1	60	1	30	30	1
LATERAL SKULL	30	50	1	40	1	40	1	30	20	1
DORSAL SPINE, A. P.						35	1	30	20	1
DORSAL SPINE, LAT.						35	2	30	20	2
LUMBAR SPINE, A. P.						50	1	30	25	1
LUMBAR SPINE, LAT.						100	2	30	50	2
PELVIS, A. P.						40	1	30	20	1
KIDNEY, A. P.						40	1	30	20	1
RIBS BELOW DIAPH.						40	1	30	20	1
GALL BLADDER	30	50	1	50	1	50	1	30	50	1
STOMACH & COLON	30	50	1	50	1	50	1	30	50	1
CERVICAL SPINE, A. P.	48	50	4	50	4	50	4	36	25	4

MISCELLANEOUS – WITH BUCKY

PART	ADULTS DISTANCE	ADULTS M.A. SECONDS	ADULTS SCALE	AGED M.A. SECONDS	AGED SCALE	CHILDREN M.A. SECONDS	CHILDREN SCALE
HEAD, A. P.	30	175	1	150	1	150	1
FRONTAL SINUS	30	150	1	125	1	125	1
ETHMOIDS	30	225	1	175	1	175	1
SPHENOIDS	30	225	1	175	1	175	1
MASTOIDS, LAT.	30	225	1	175	1	175	1
LATERAL SKULL	30	150	1	125	1	125	1
DORSAL SPINE, A. P.	30	150	1	125	1	125	1
DORSAL SPINE, LAT.	30	150	2	125	2	125	2
LUMBAR SPINE, A. P.	30	200	1	150	1	150	1
LUMBAR SPINE, LAT.	30	350	2	275	2	275	2
PELVIS, A. P.	30	175	1	150	1	150	1
KIDNEY, A. P.	30	175	1	150	1	150	1
RIBS BELOW DIAPH.	30	175	1	150	1	150	1
GALL BLADDER	30	50	3	50	3	50	3
STOMACH & COLON	30	50	3	50	3	50	3
CERVICAL SPINE, A. P.	30	100	2	75	2	75	2

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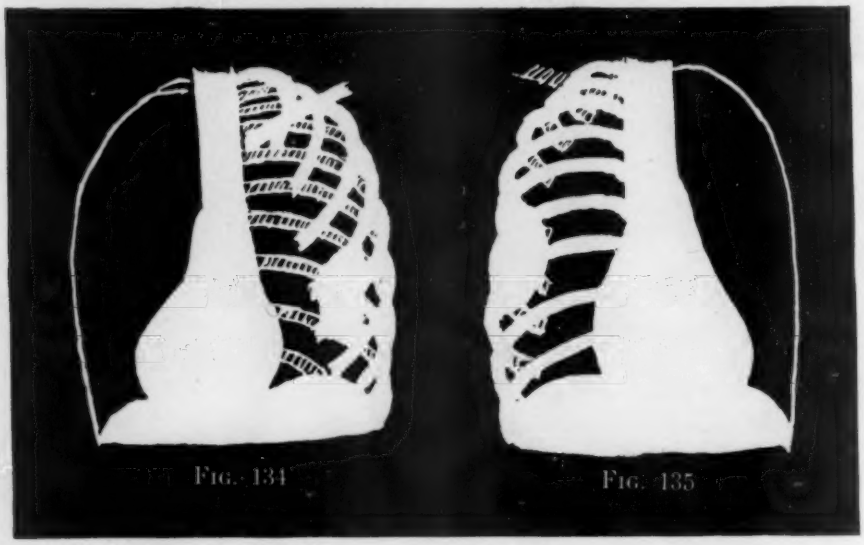

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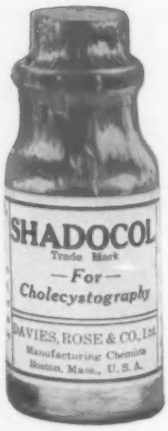

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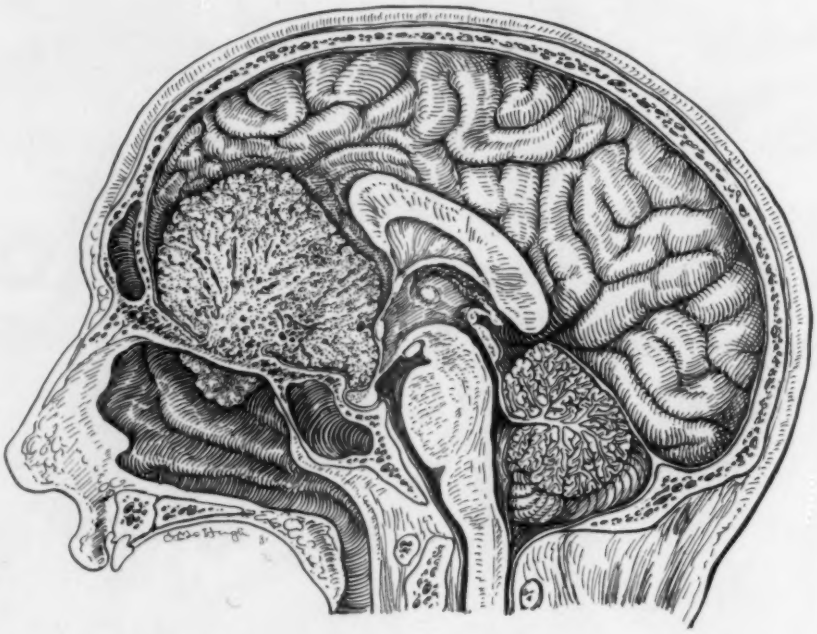

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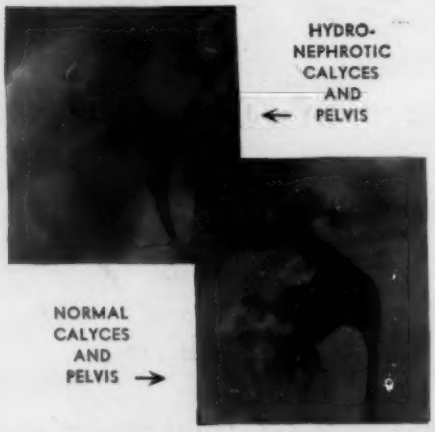

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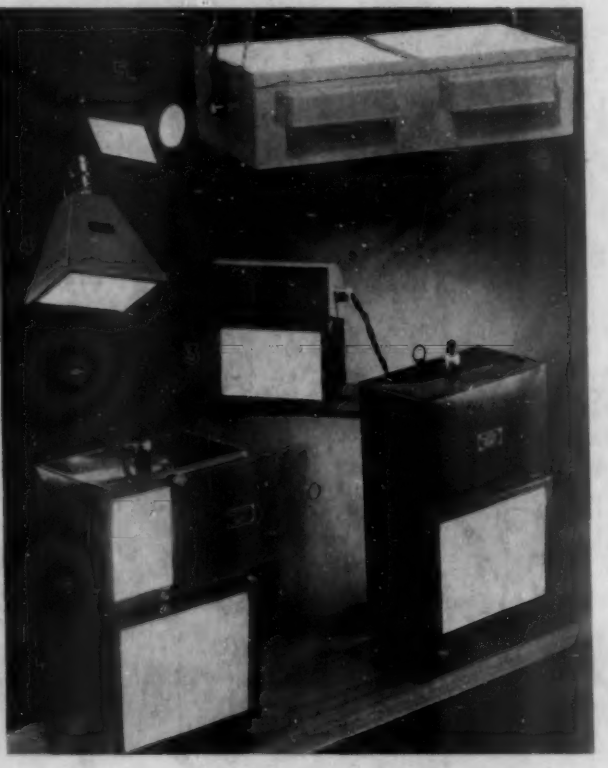

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